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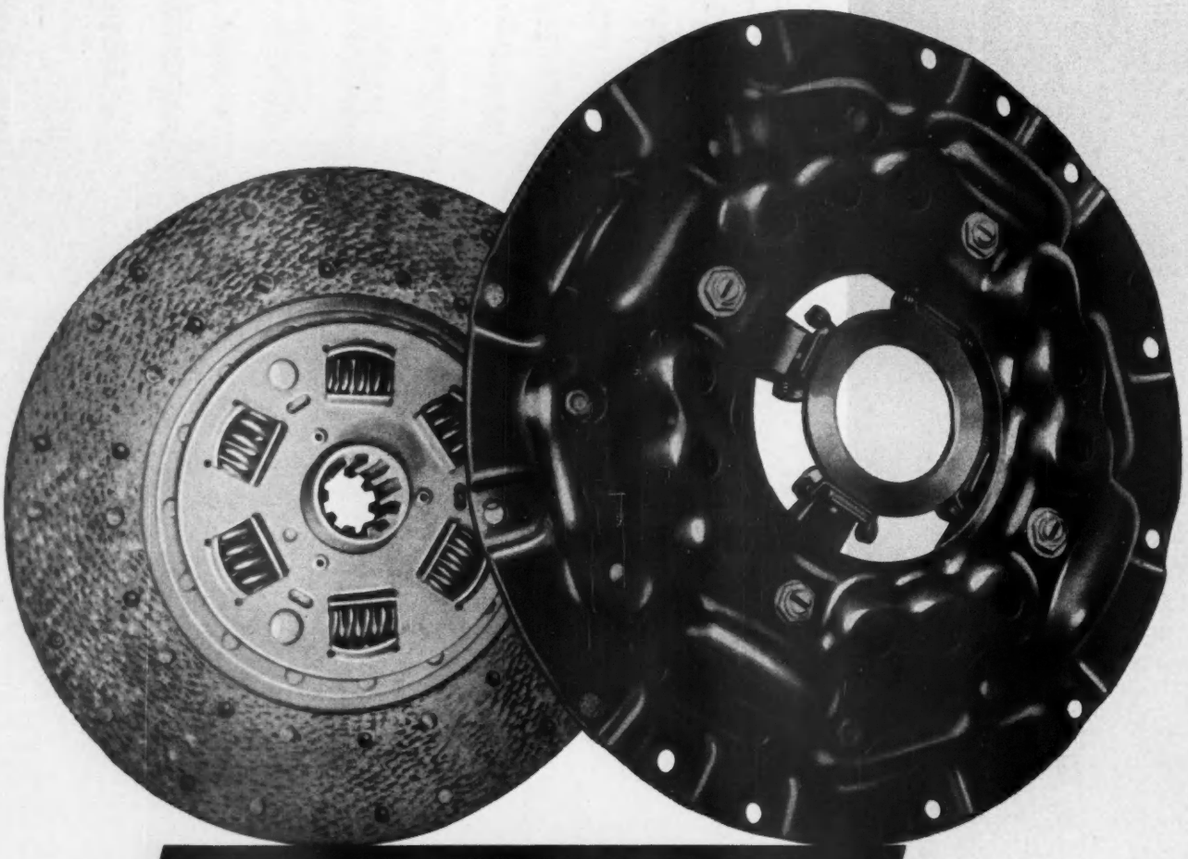

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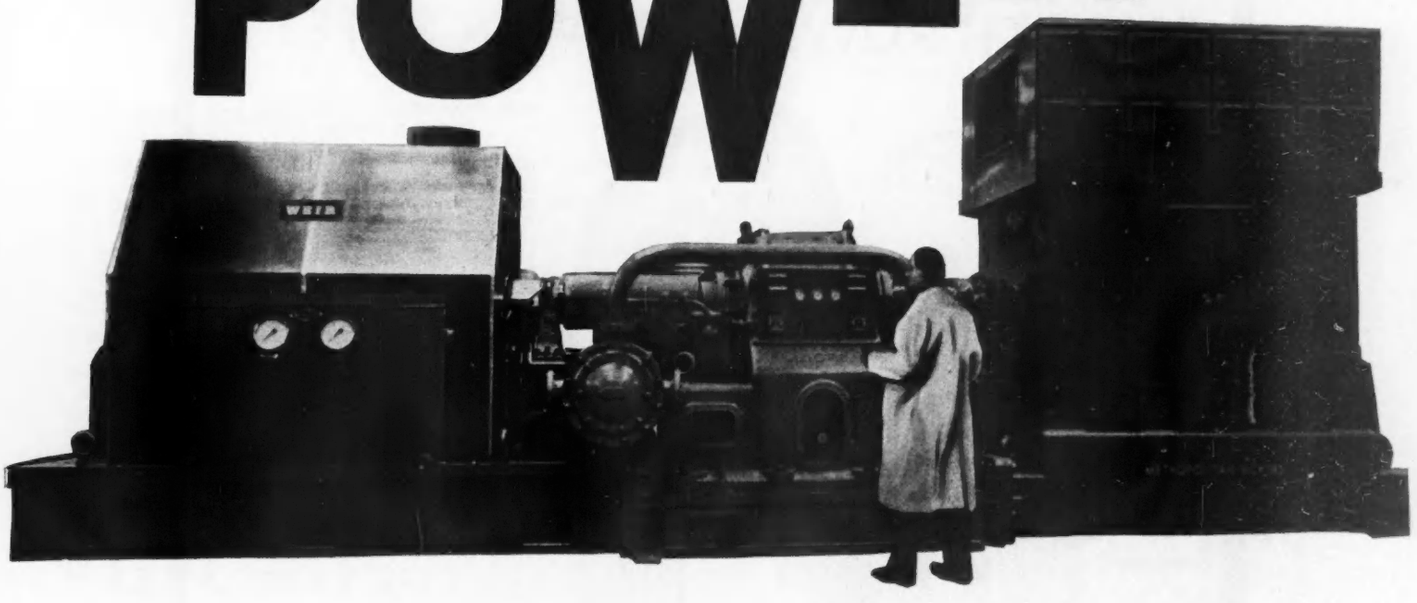

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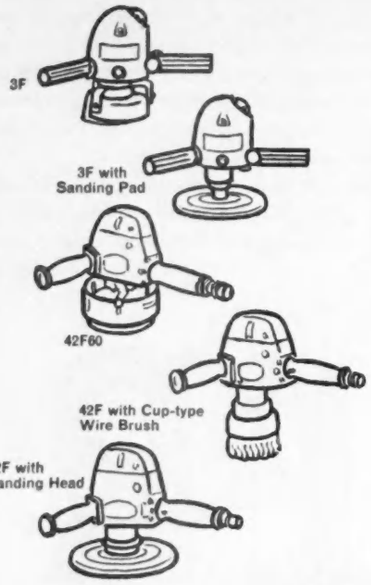

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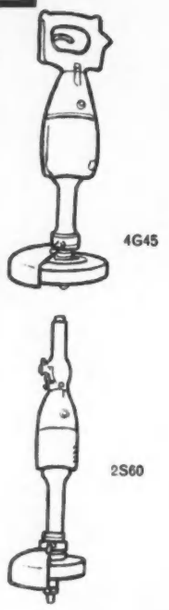

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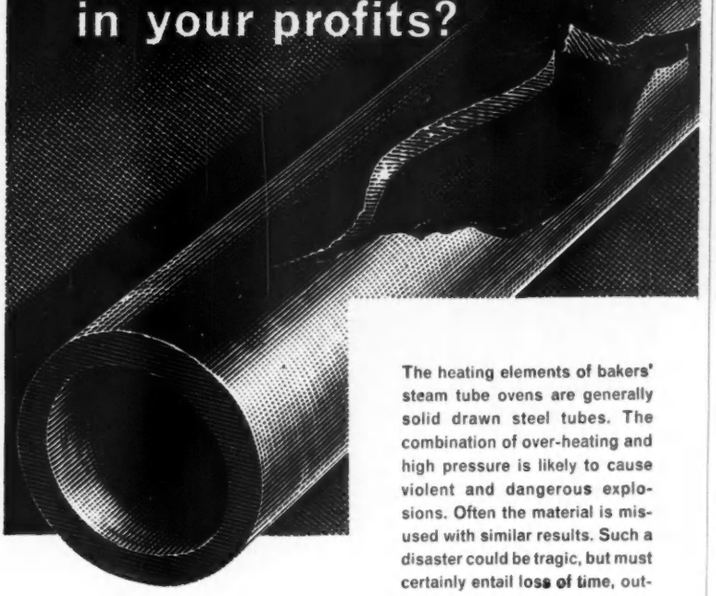
bit of tube

could blow a hole

in your profits?



The heating elements of bakers' steam tube ovens are generally solid drawn steel tubes. The combination of over-heating and high pressure is likely to cause violent and dangerous explosions. Often the material is misused with similar results. Such a disaster could be tragic, but must certainly entail loss of time, output and profits.

Vulcan know

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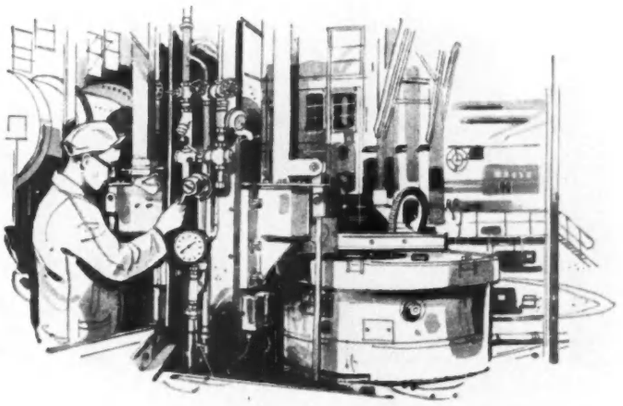

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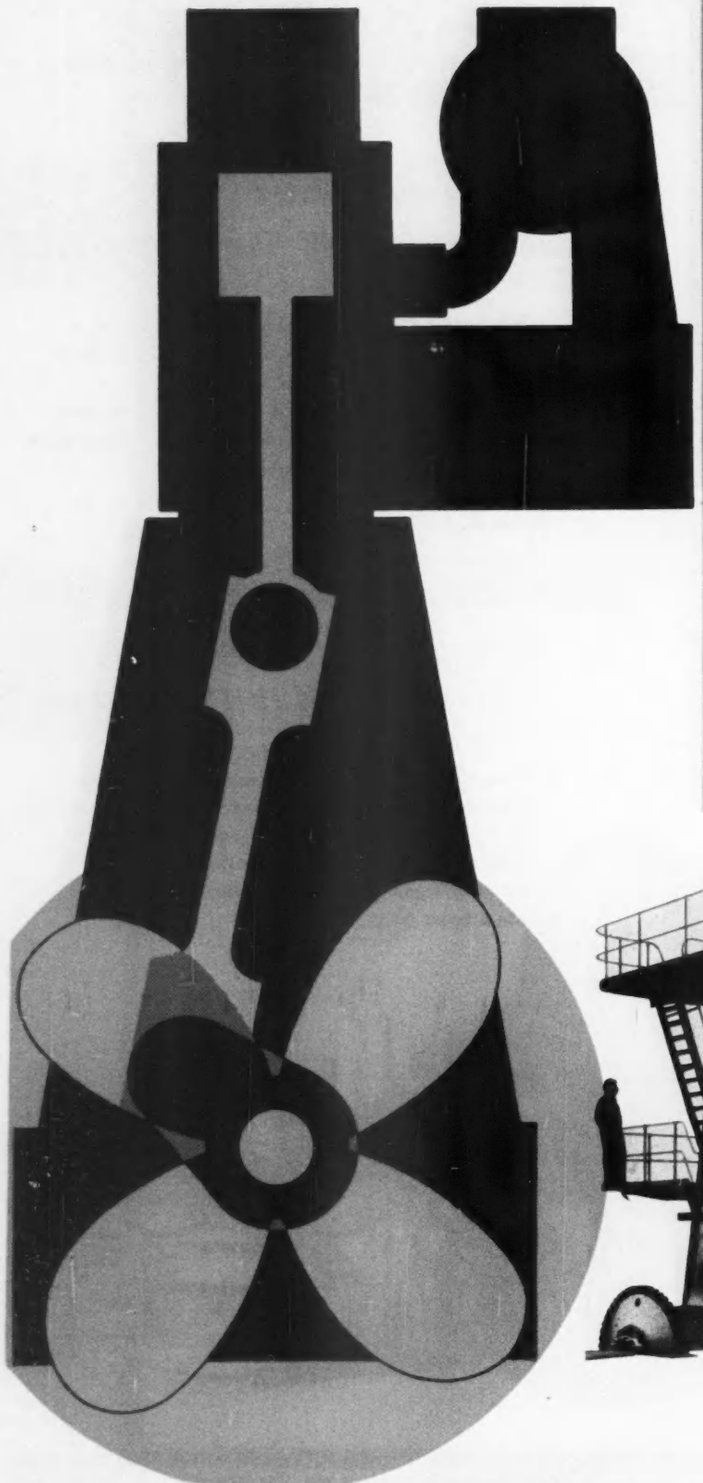

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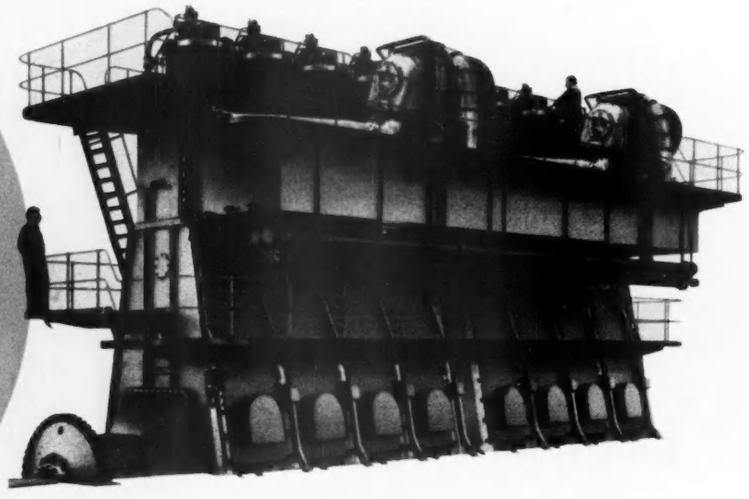

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16 December 1960

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ENGINEERING

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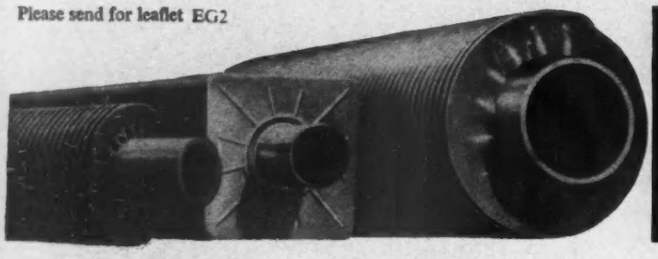

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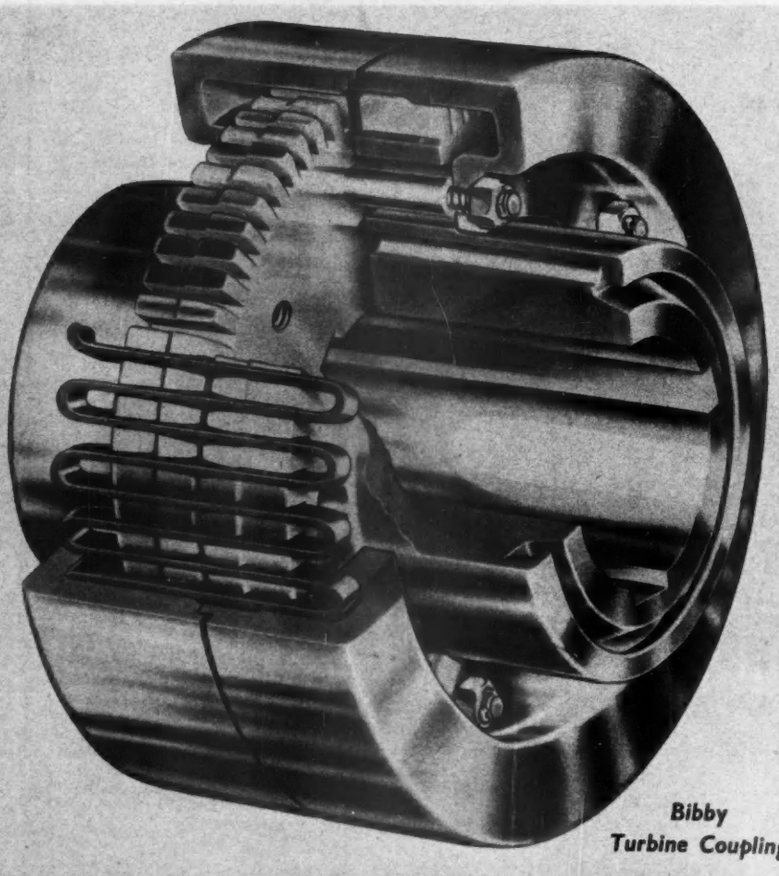

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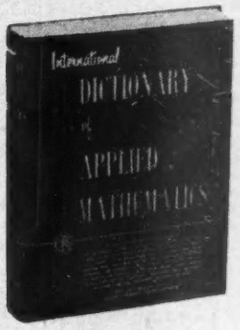

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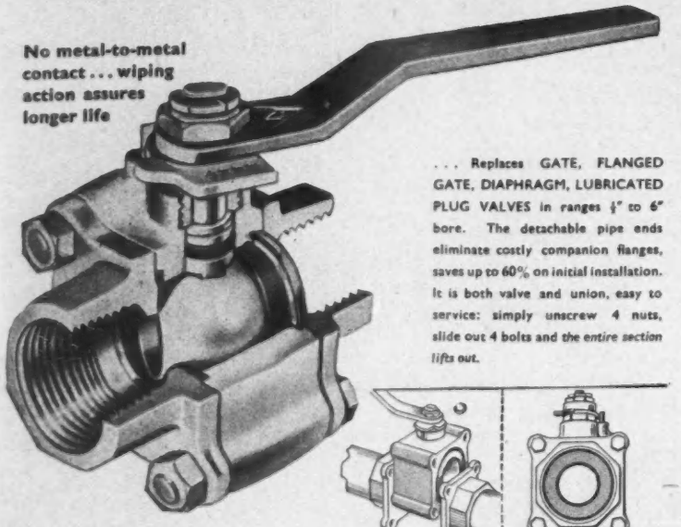

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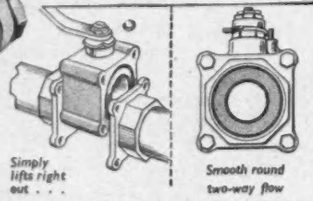

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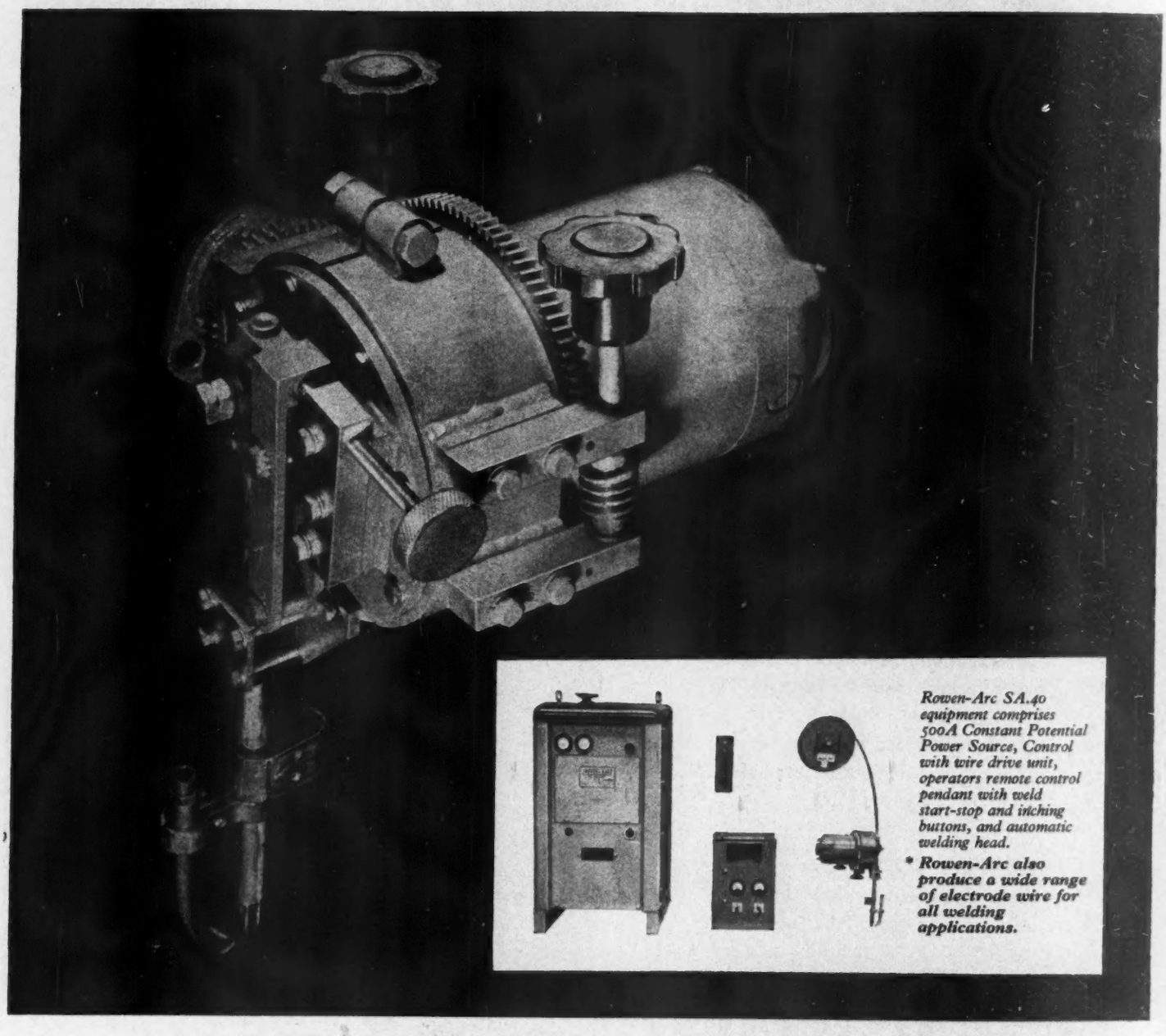

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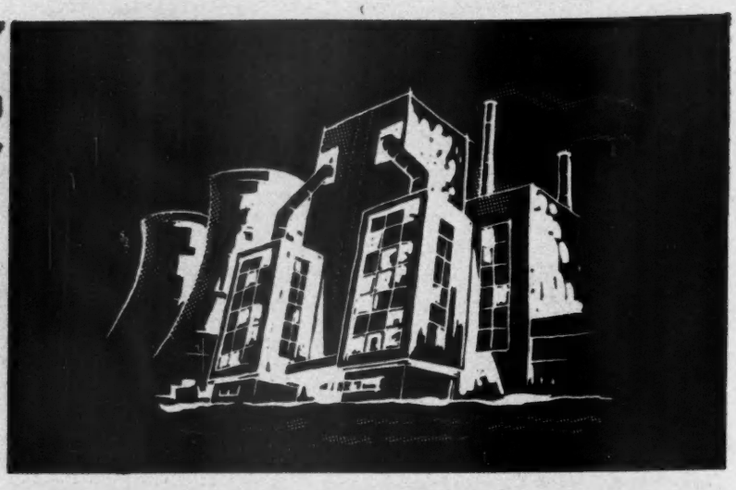

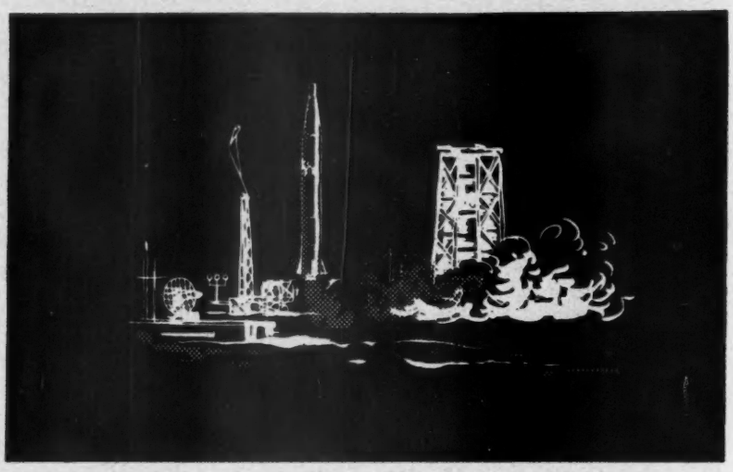

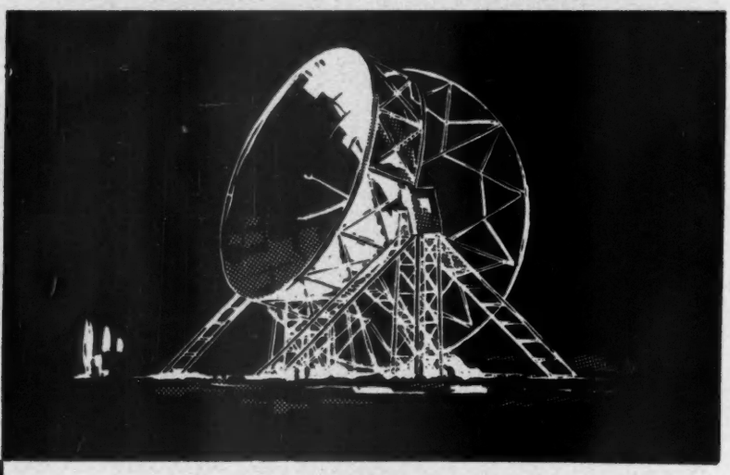

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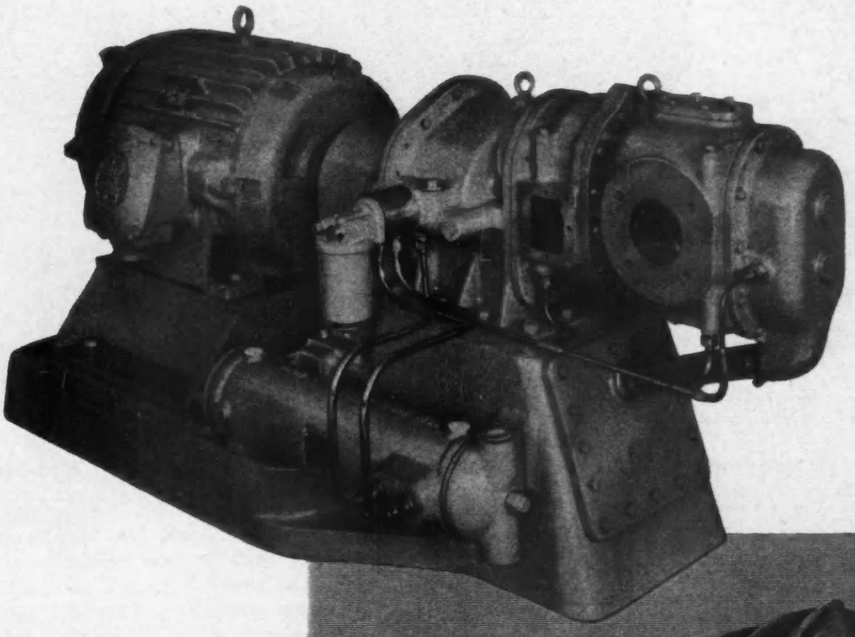

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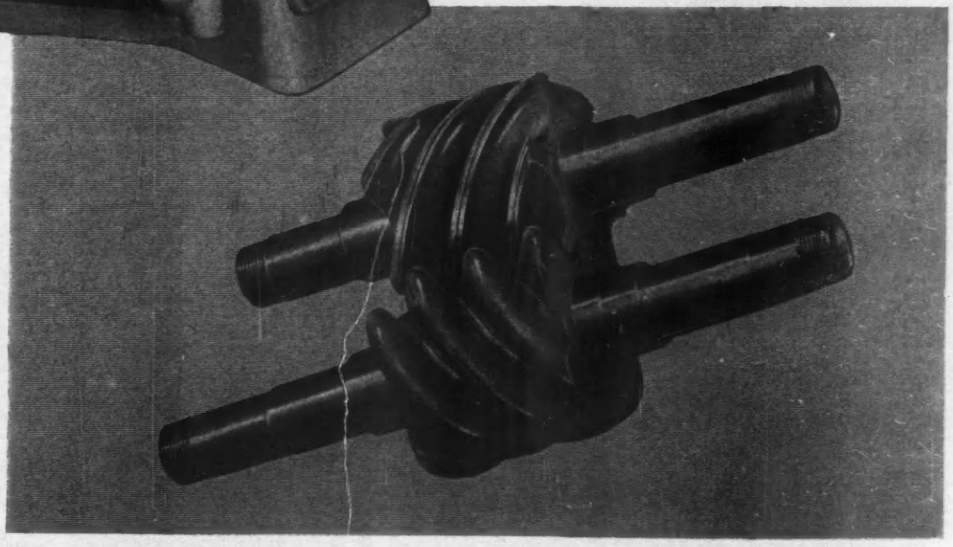

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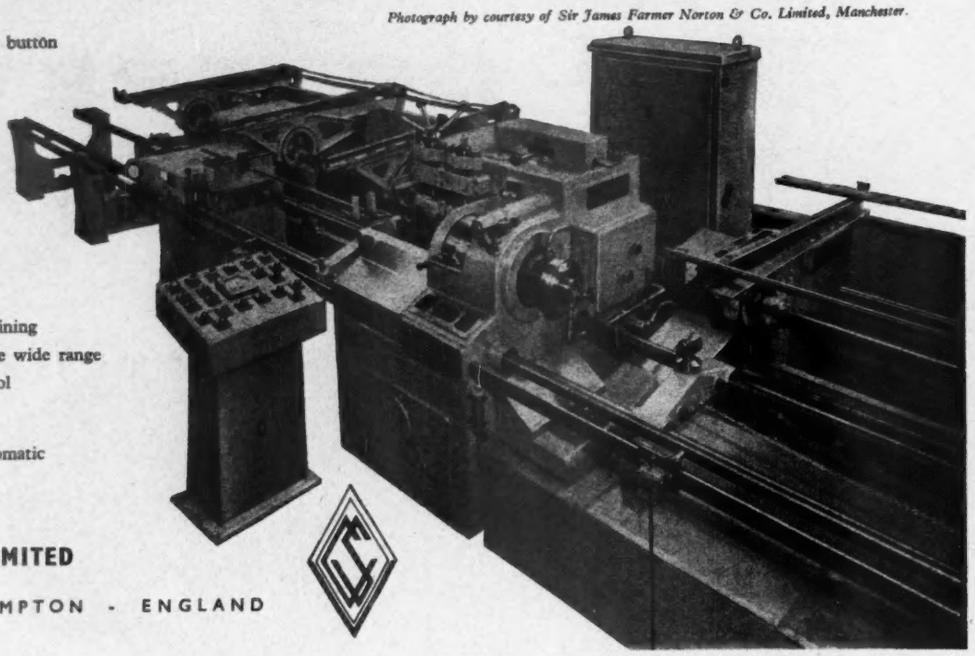

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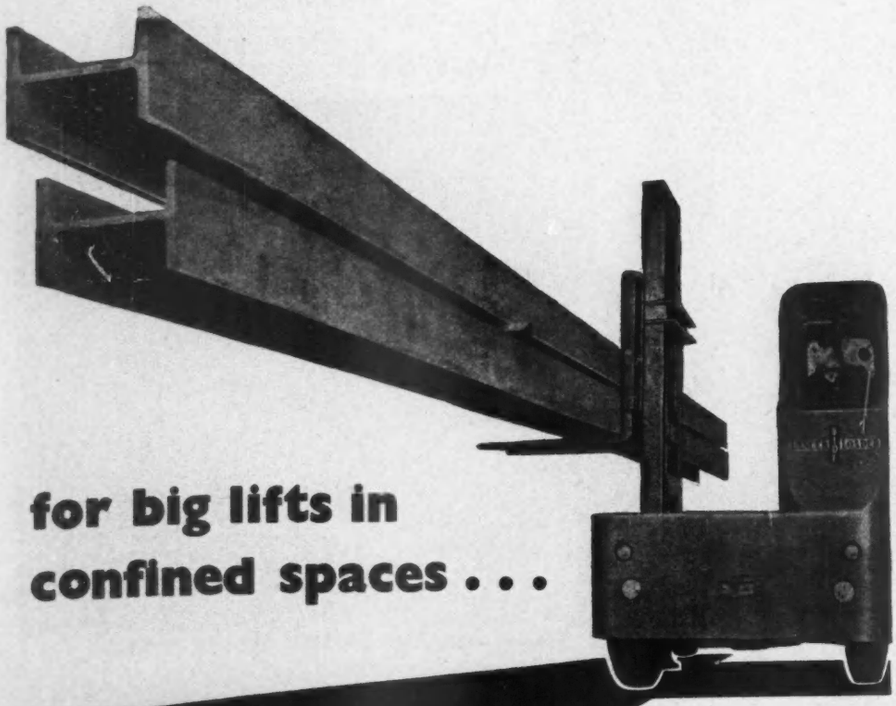

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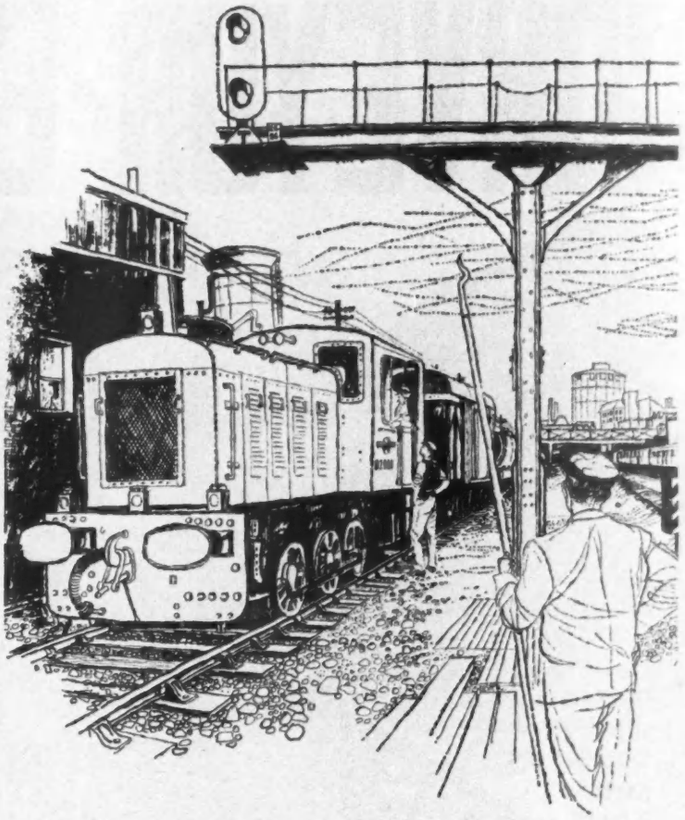

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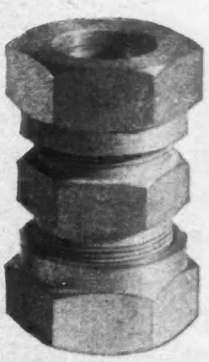

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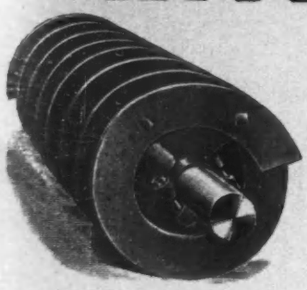

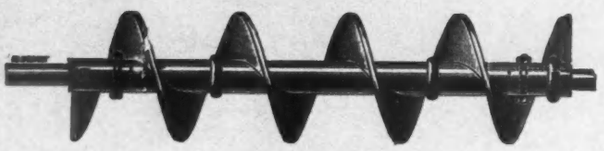

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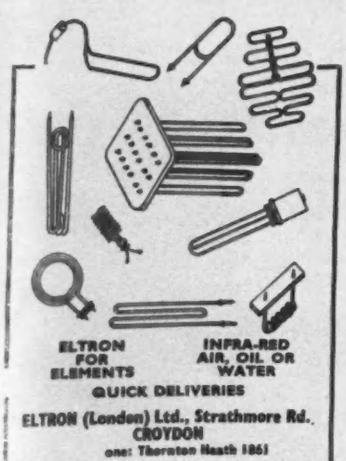

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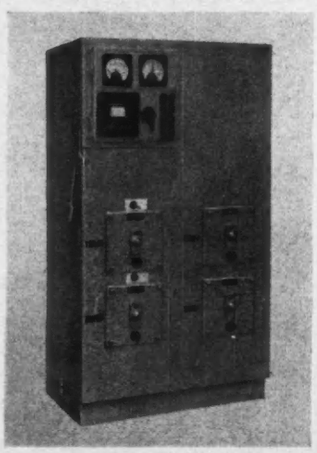

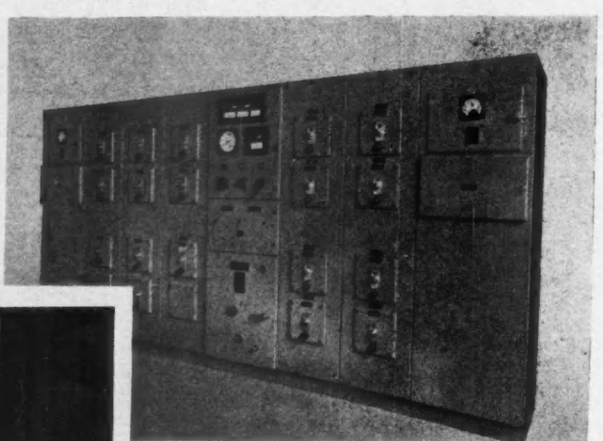

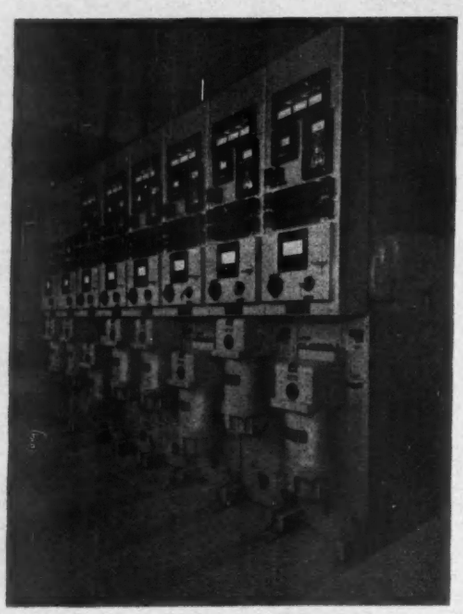

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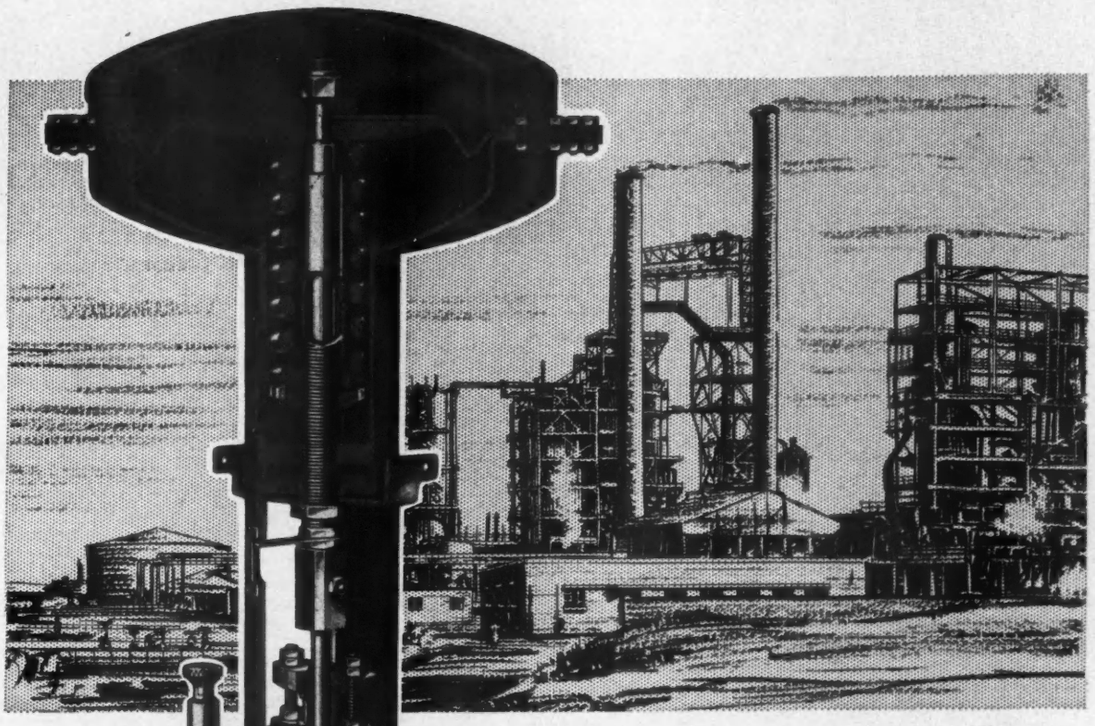

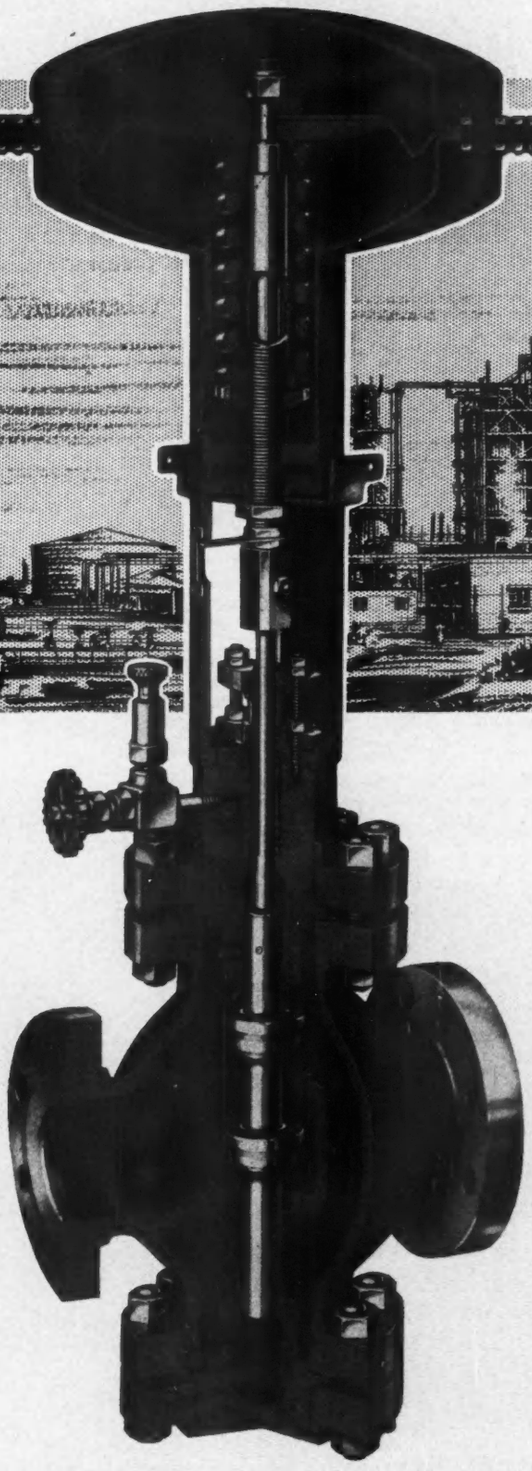

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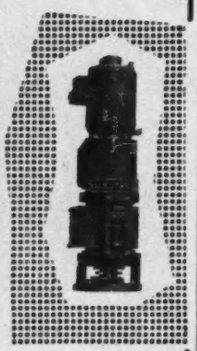

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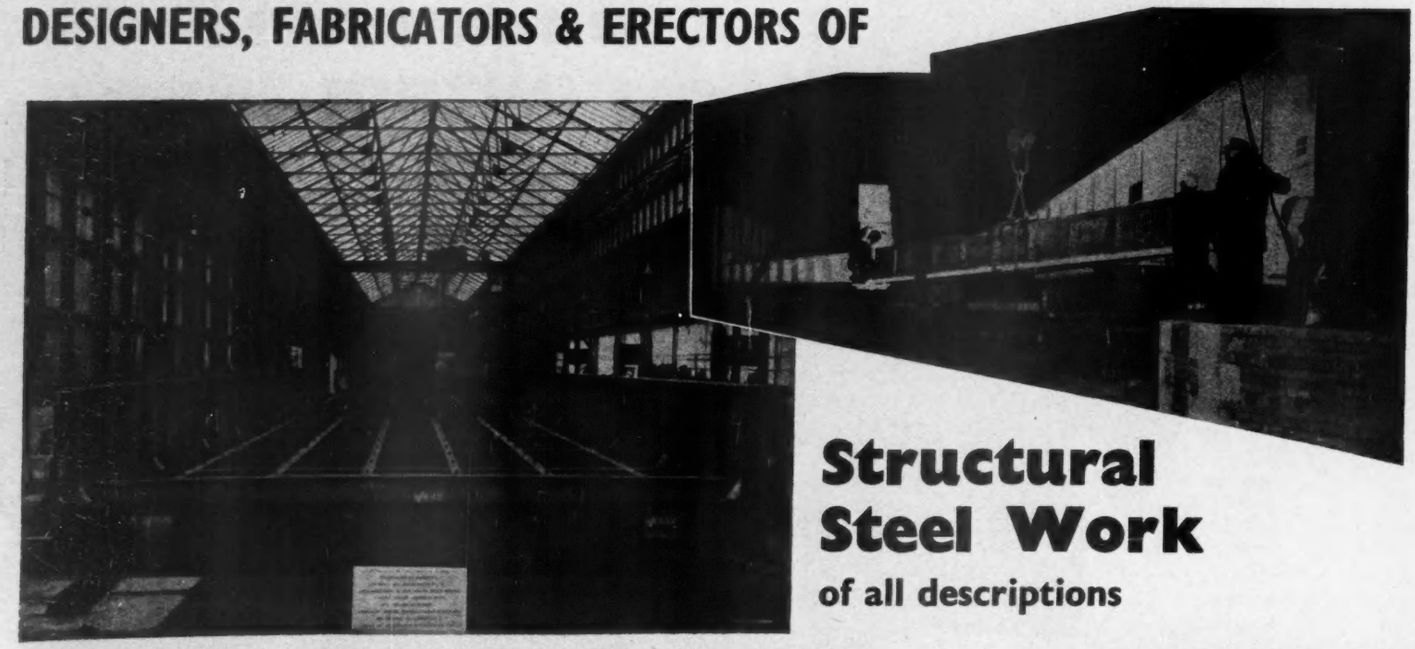

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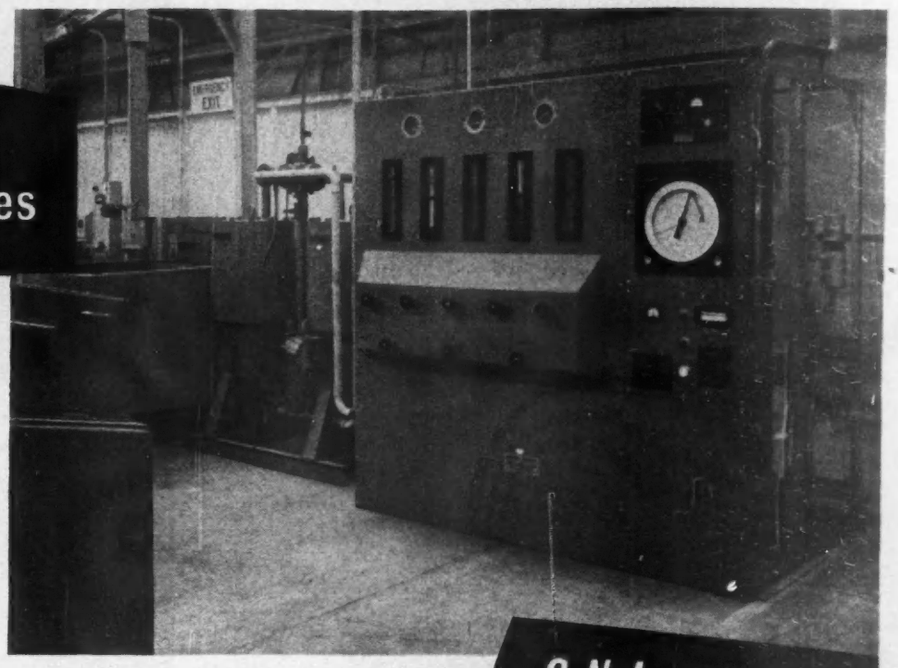

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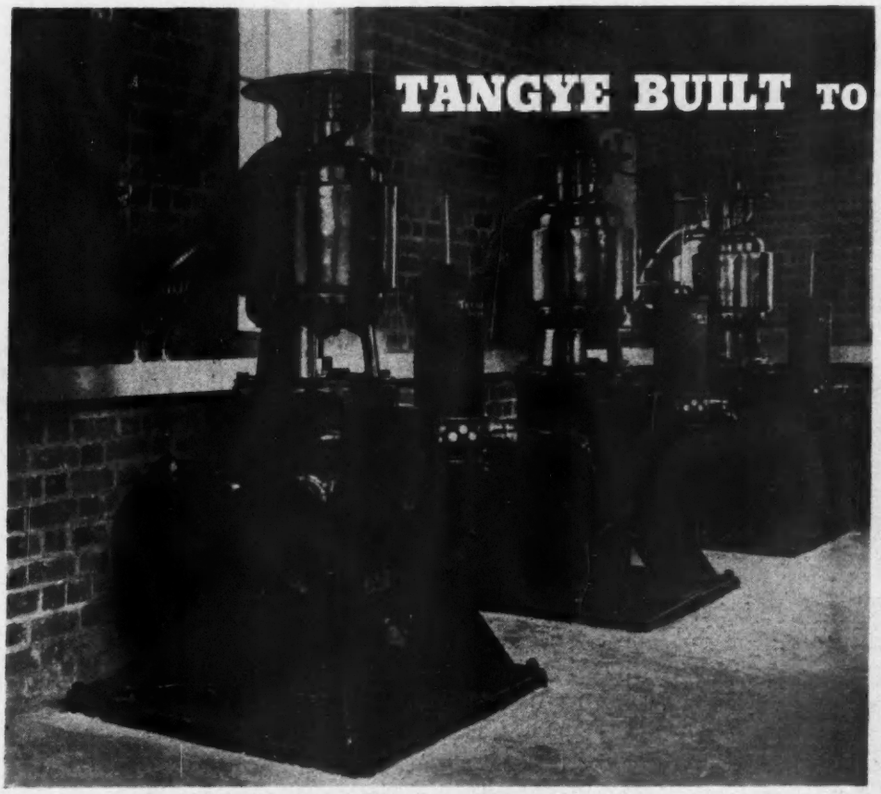

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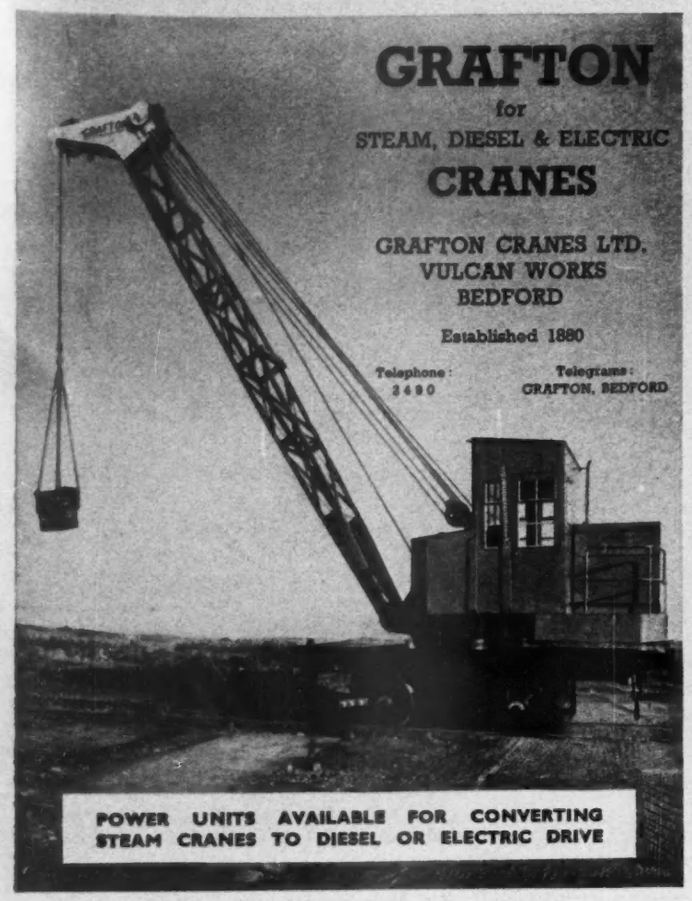

Two train loads of rails and switches leaving Summersons' Spennymoor Works.

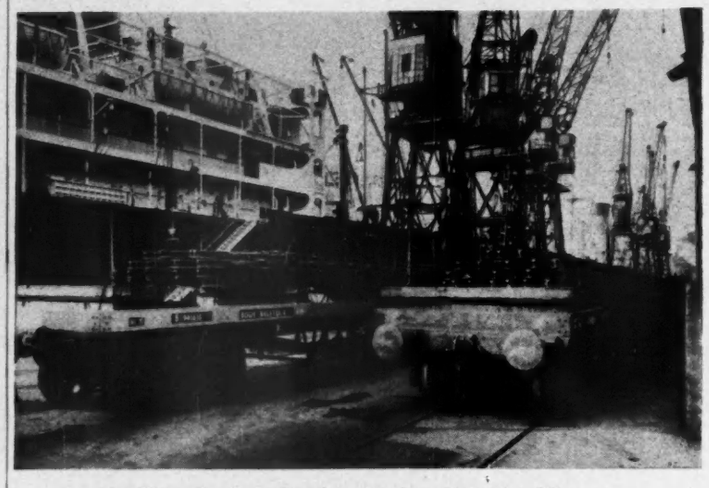

Illustration shows part of two complete trains used to deliver

SUMMERSON 'Designing' wins big Thailand contract for rails and switches

In the face of keen worldwide competition, Summersons obtained a contract from the State Railways of Thailand comprising 115 turnouts angle 1 in 10, complete with over-riding switches and cast manganese vee pieces, also seven diamond fixed crossings, angle 1 in 10, including two acute crossings with cast steel vees and two obtuse crossings. Ancillary equipment was also supplied.

Good designing was a deciding factor, and Summersons 120 years of experience of designing, manufacturing and laying railway track stood them in good stead. *Write for a copy of Summersons Book of Railway Sidings.*

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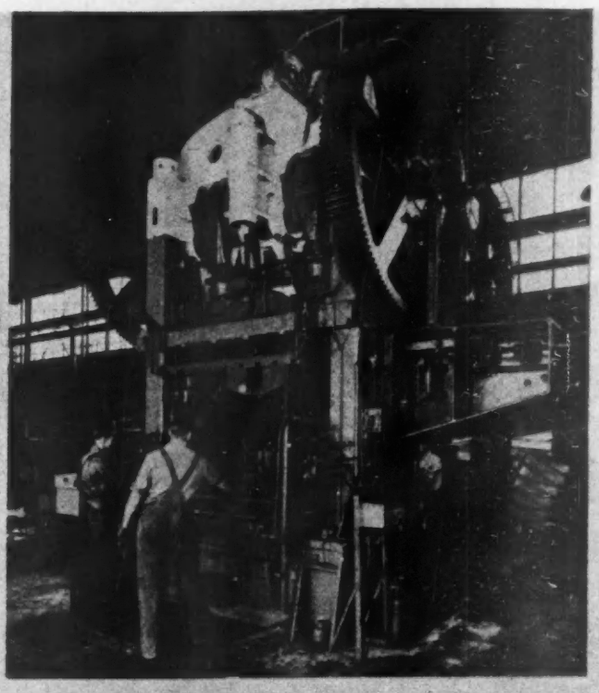

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Messrs. N. C. Joseph Ltd., Stratford-upon-Avon, manufacturers of 'Sona' Aluminium Household Ware, Steel Pressings, etc., re-equipped the press illustrated for 'All-Air' Control with Ross Air Valves in June, 1956. The press has since been in constant production, the valves having operated without fault or maintenance.

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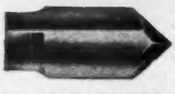
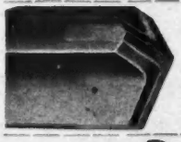


RAWLDRILLS — For hand boring for Rawlbolt sizes A to G.

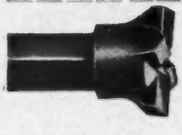
STARDRILLS — For hand boring for all Rawlbolt sizes.

DURIUM TIPPED DRILLS — For use in hand and electric drills for Rawlbolt sizes C to G.

TRIFORM DRILLS — For use in electric hammers for Rawlbolts sizes C to K.



DURIUM HAMMER DRILLS — For use in electric hammers for Rawlbolt sizes C to J.



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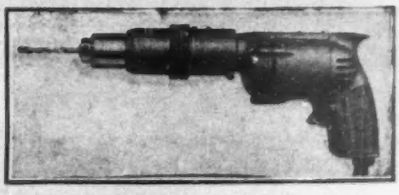
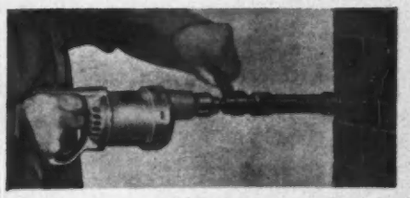
The Vibroto R.V.1 and R.V.2 machines combine rotary with vibratory action for making holes in exceptionally hard masonry. Special hard tipped drills are used, and the power of the vibration can be adjusted to light or heavy as required. The machines can be converted to rotary action only for use with Durium masonry drills or standard twist drills. Chuck Capacities R.V.1 ¼in., R.V.2 ⅜ in.
Technical folder V1535/3 provides full details.





Drill Hammer Attachment

When fixed to an electric drill this attachment will convert the rotary motion to percussion action at the rate of one blow per revolution. Any type of electric drill up to 2,000 r.p.m. can be used and the power of the blow can be adjusted to light, medium or heavy to suit the hardness of the masonry. Special "H" type Rawldrills are used. Capacity ¼in. to ½in.
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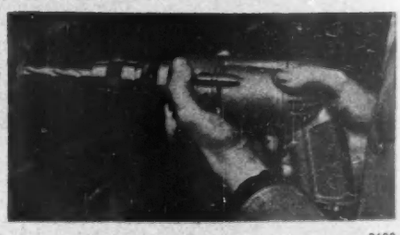
Technical folder R1573/1 provides full details.



B6EB

THE RAWLPLUG COMPANY LIMITED, CROMWELL ROAD, LONDON, S.W.7

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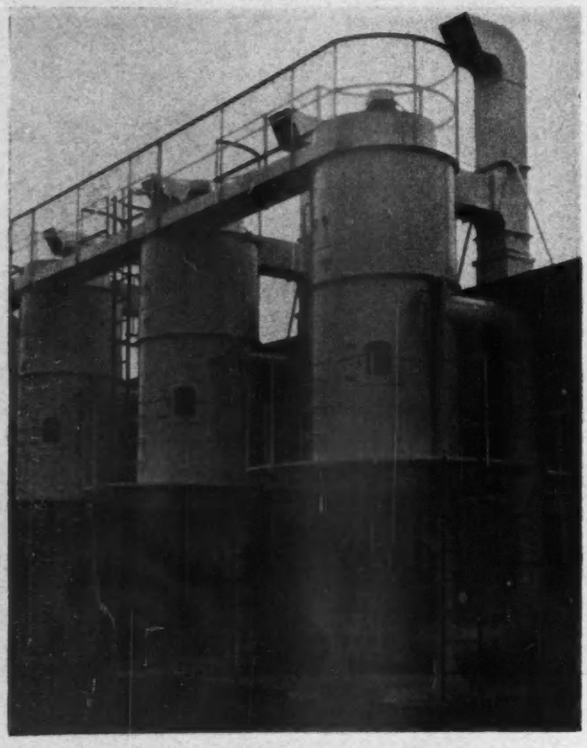
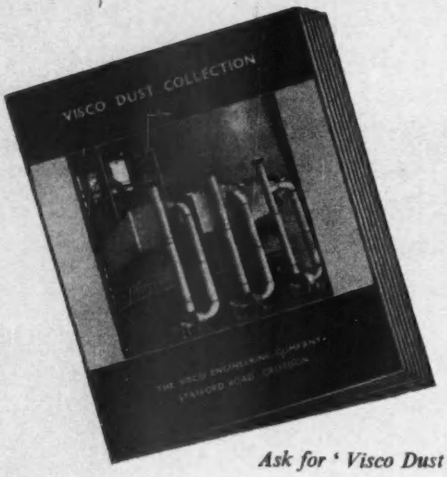


If you have a dust recovery or powder handling problem of any kind, you will find our latest brochure useful and interesting. In it we discuss dust collection in general and give numerous examples of the application of dust recovery equipment to various industries. The information in the brochure is based on many years' experience in dealing with practically every kind of material in powder or fibrous form. It also contains illustrations showing different types of equipment varying from large centralized plant to small units for use with individual grinding or polishing machines. Enquiries invited to THE VISCO ENGINEERING CO., LTD., Stafford Road, CROYDON. Croydon 4181.



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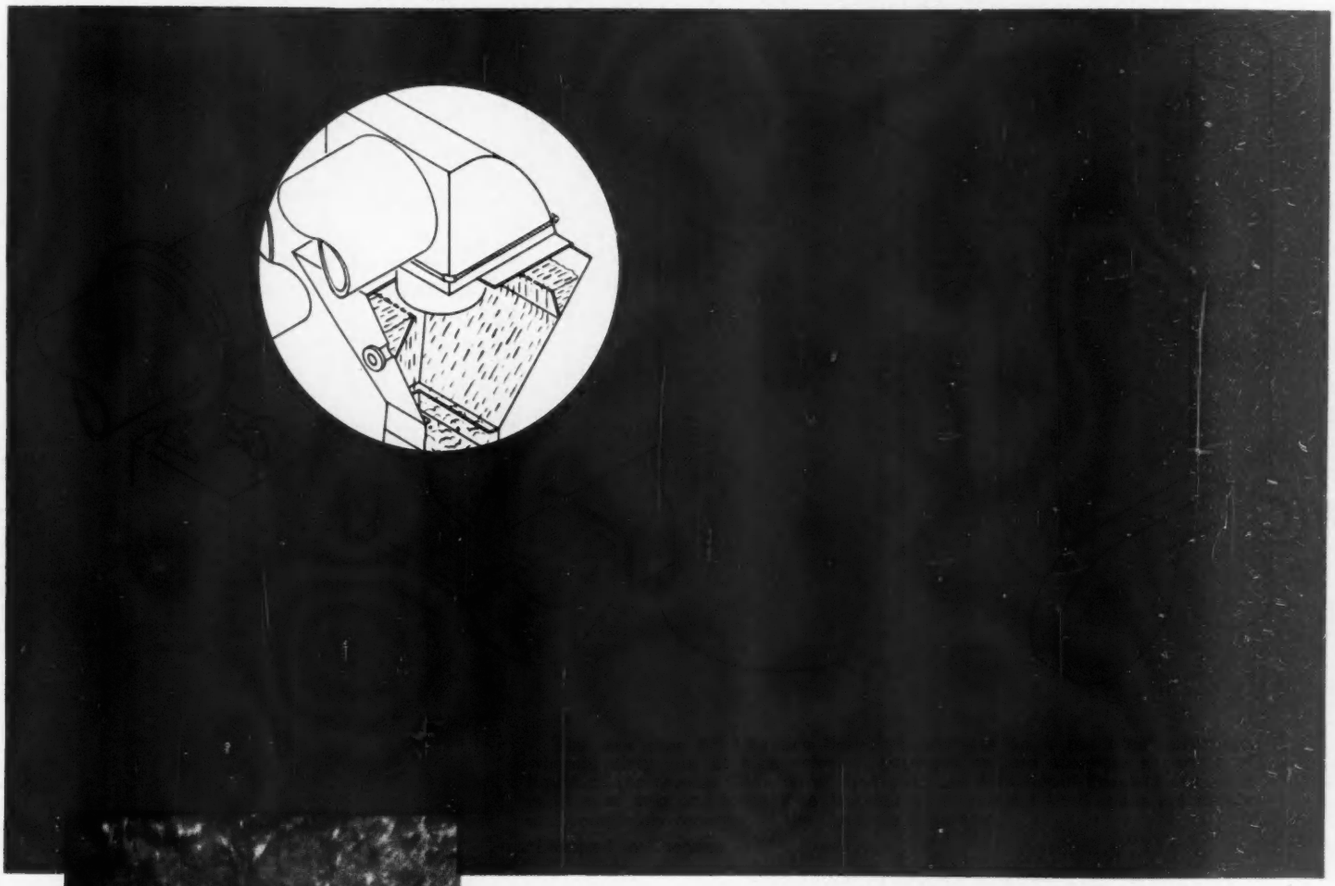
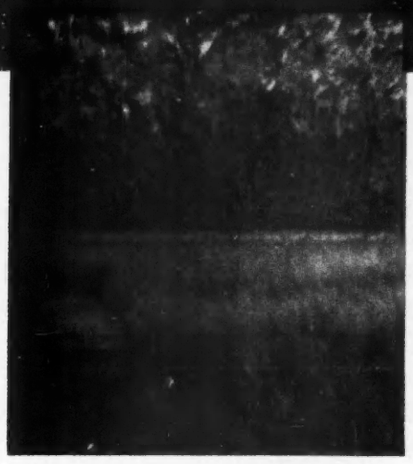
99% Scrubbing efficiency! Maintenance-free operation!





Actual photograph of throat action

A recent installation of the new type S.F. CHEMICO Venturi Scrubber is handling 40,000 cfm of hot gases from a 10′ x 250′ rotary Kiln and achieving over 99% removal of Lime dust from the kiln exhaust. No maintenance difficulties have been experienced and the unit is virtually foolproof, despite the use of a recycled slurry containing over 45% solids and many large lumps. The CHEMICO type S.F. Venturi Scrubbers are low cost, compact and readily installed in your plant.

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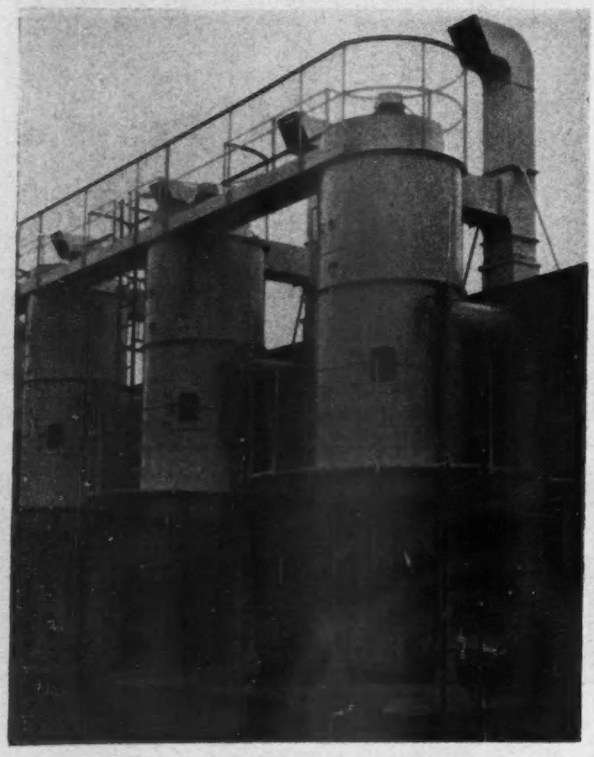

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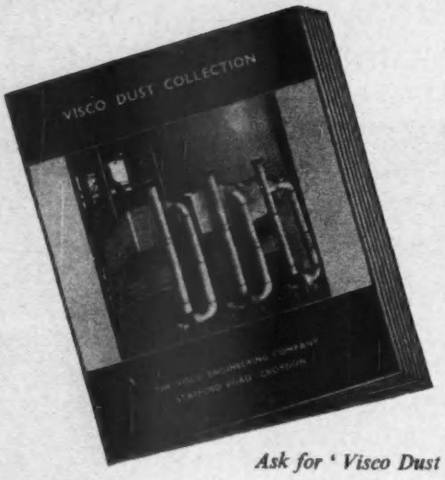

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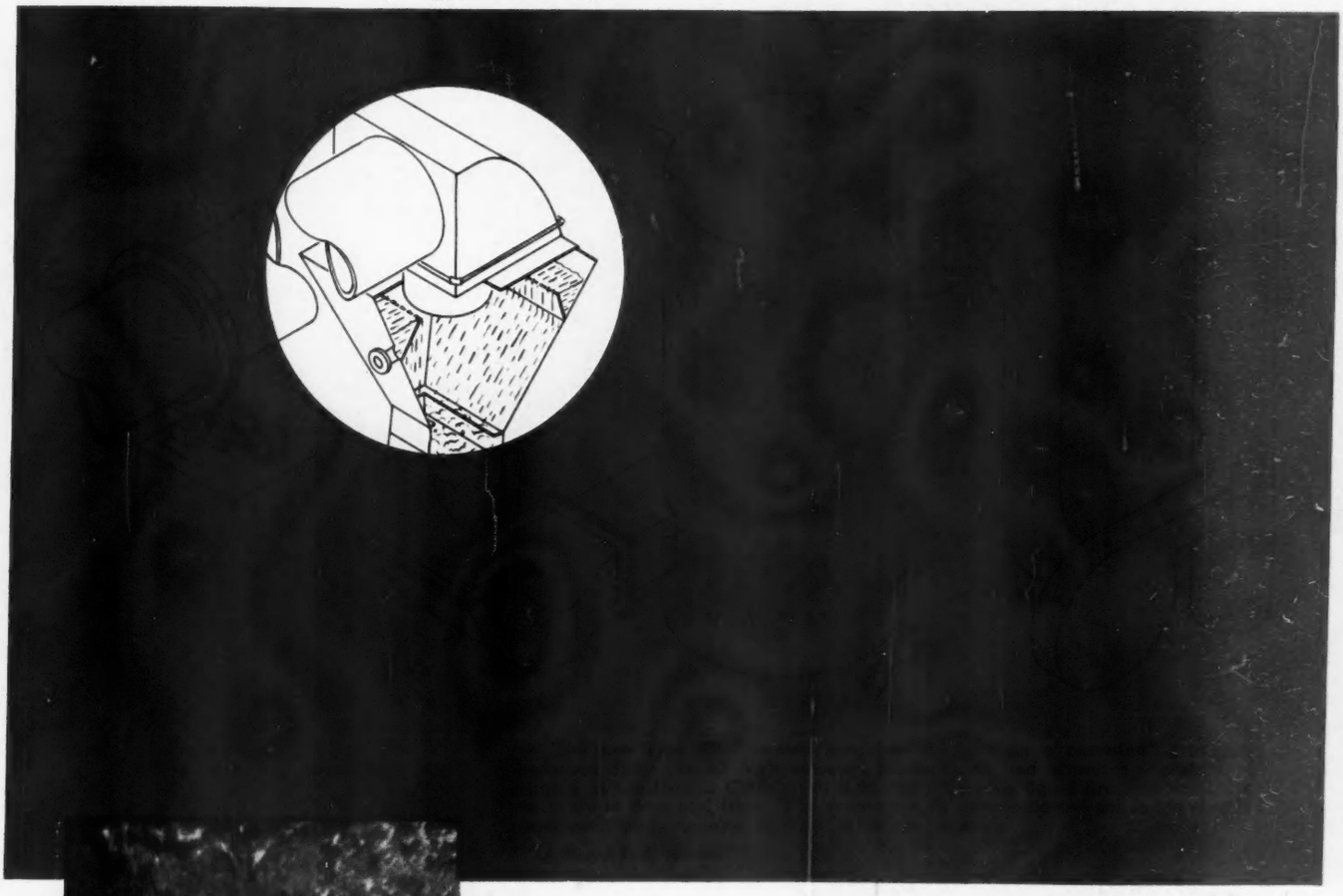

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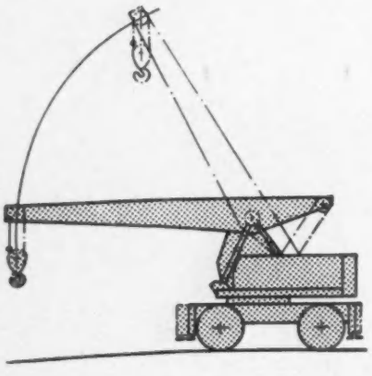
BRITAIN'S NEWEST CRANE



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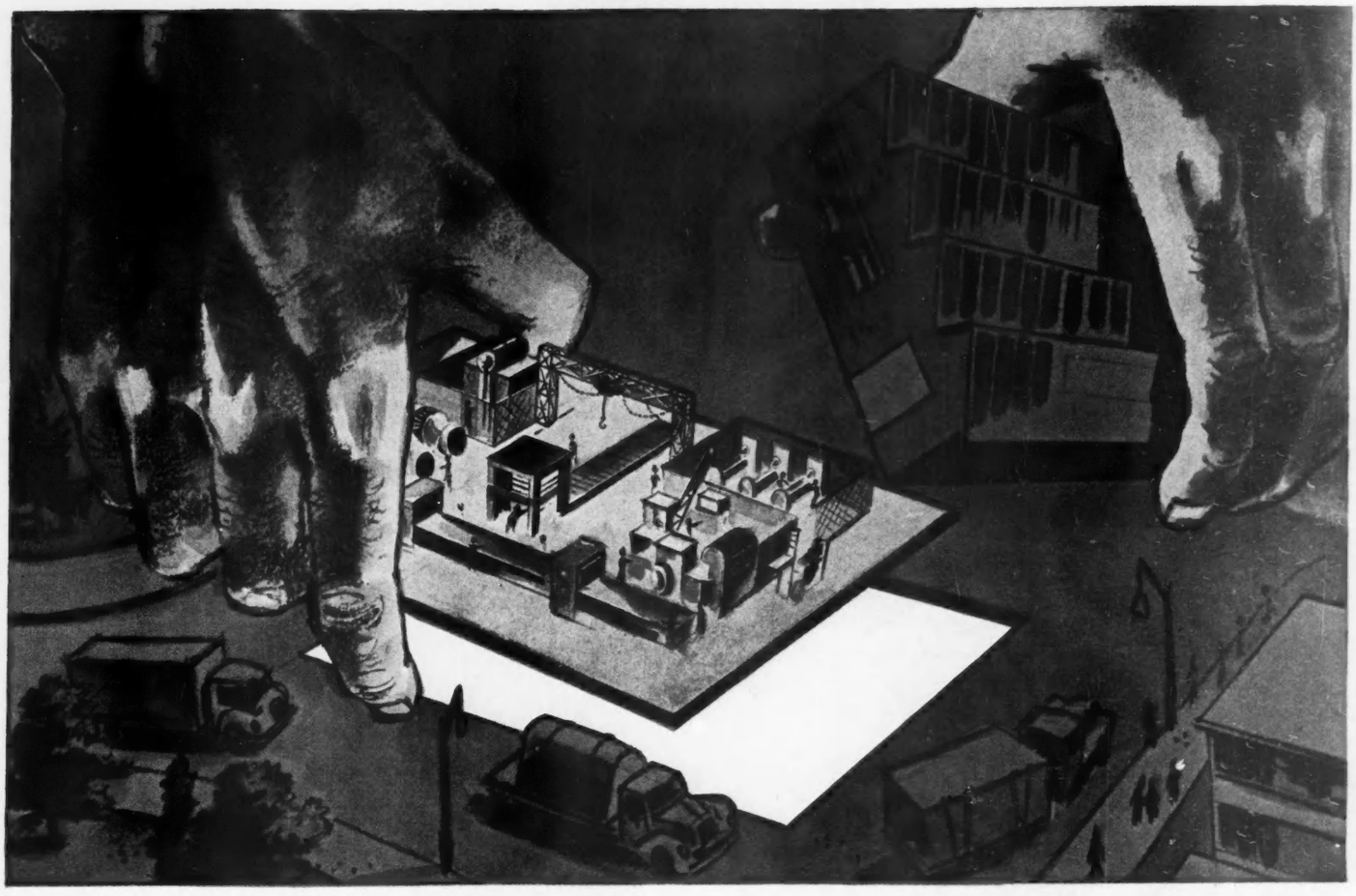

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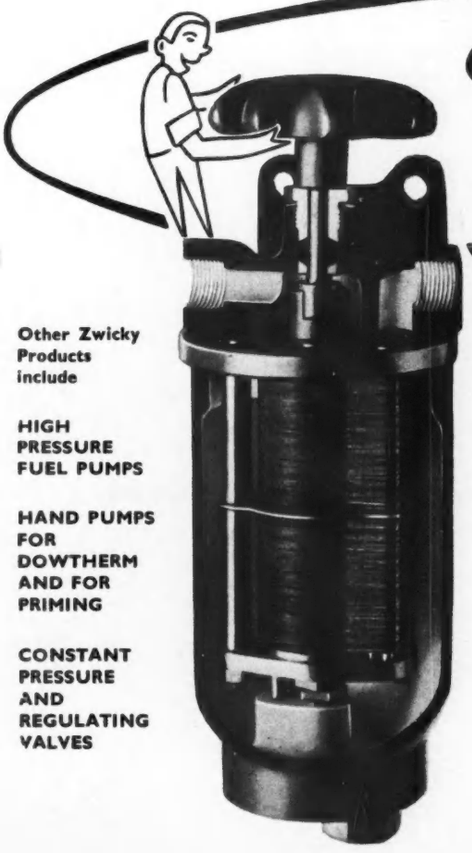

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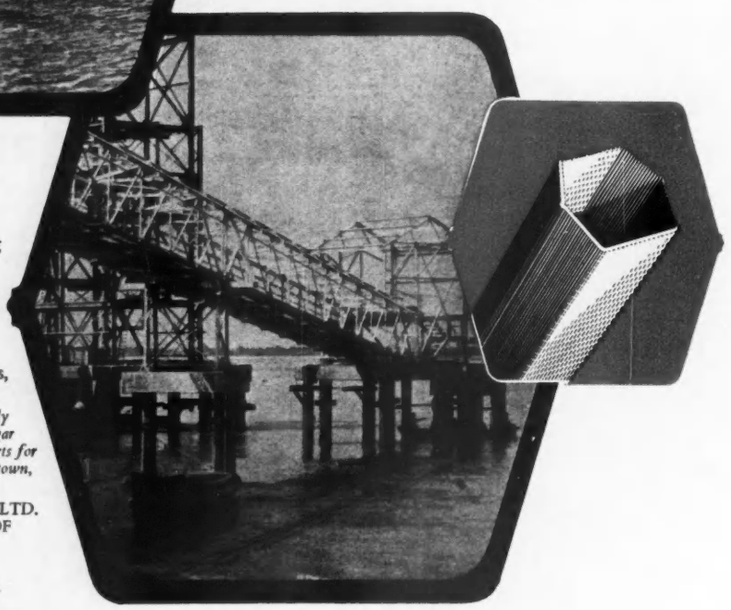

South Durham "Rendhex" Foundation Columns combine lightness in weight with great strength and maximum load-bearing capacity. They are in world-wide demand for the construction of deep-water foundations for off-shore anchorages and all types of work where piling construction is required to carry heavy vertical loads,

Illustrations show "Rendhex" Columns forming (above) a "strongpoint" in a recently constructed jetty to berth 10,000 ton bulk sugar freighters and (below) acting as piling supports for a bulk sugar off-loading conveyor at Georgetown, British Guiana, for

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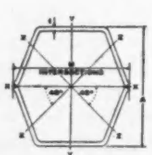

TABLE OF PROPERTIES

"Rendhex" Column No.	Size (Ins.)			Weight of Rolled Section lbs. per Lin. ft.	Weight of complete Col. (incl. Weld) lbs. per Lin. ft.	Area of complete Col. (excl. weld) Sq. ins.	Moment of Inertia (Ins.⁴)			Radii of Gyration (Ins.)			Section Moduli (Ins.³)		
	A	B	t				About XX	About YY	About ZZ	About XX	About YY	About ZZ	About XX	About YY	About ZZ
No. 3	13	12½	½	36·15	72.50	21·26	469·3	381·3	425·3	4·69	4·23	4·47	72.20	58·70	57·30
No. 4	16	16½	½	58·30	117·75	34·30	1214	1038	1126	5·95	5·50	5·73	151·75	125·82	116·15
No. 6	20	20	0·7	80·70	162·80	47·47	2657·7	2203·5	2430·6	7·49	6·81	7·16	265·80	218·60	207·20

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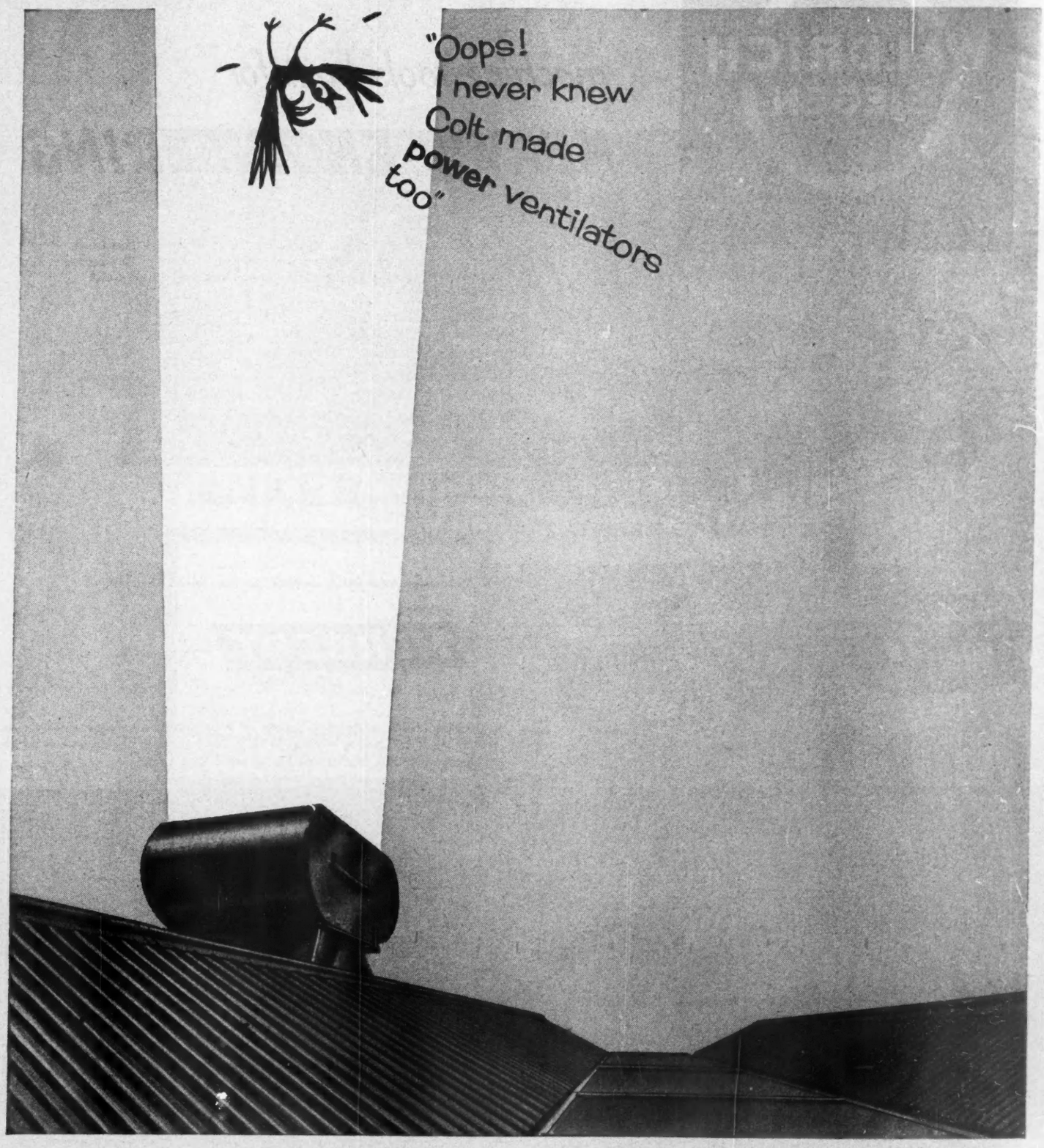

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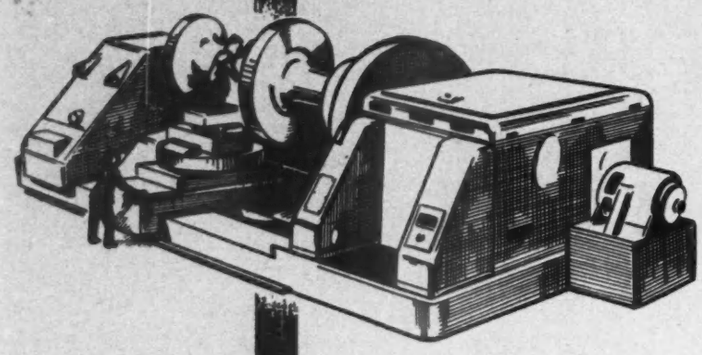
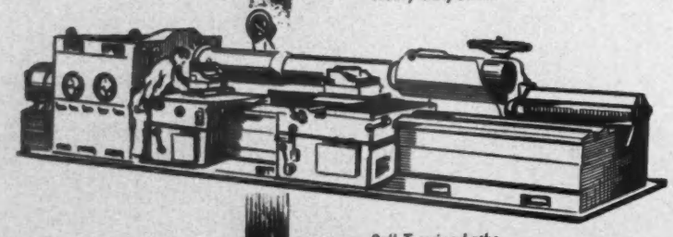


Heavy-Duty Lathe



Roll-Turning Lathe

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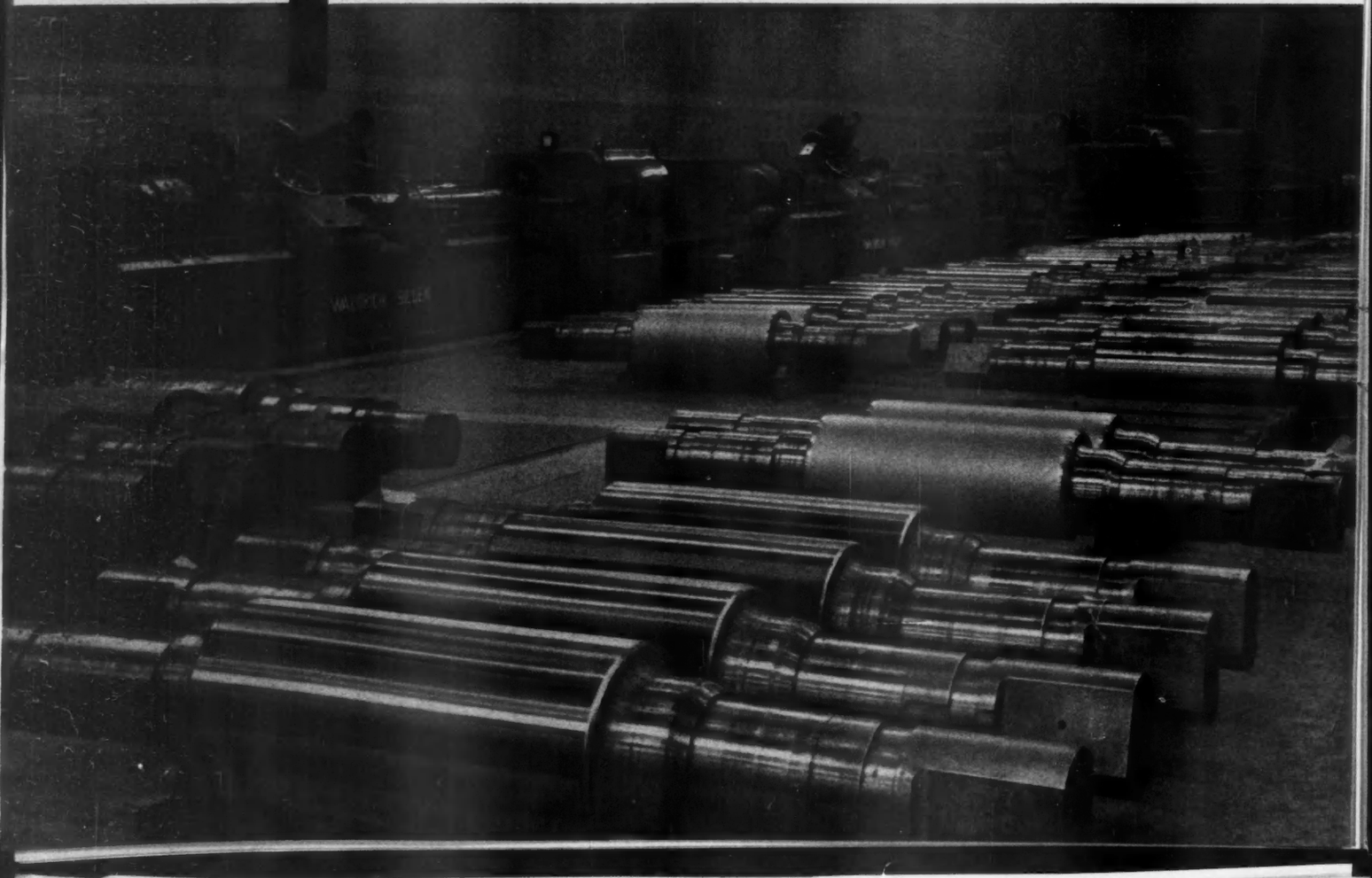
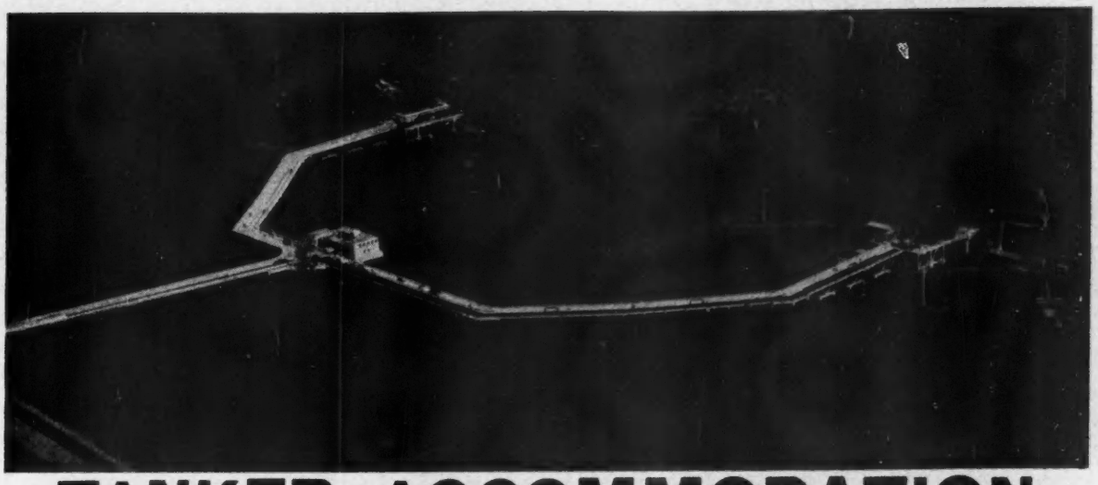
AD 599

The Tinplate Division of the Steel Company of Wales Ltd., Swansea, have installed three Waldrich-Siegen Roll Grinding Machines for rough and finish grinding of the working surface of work rolls up to 21in. diameter and back-up rolls to 53in. diameter.





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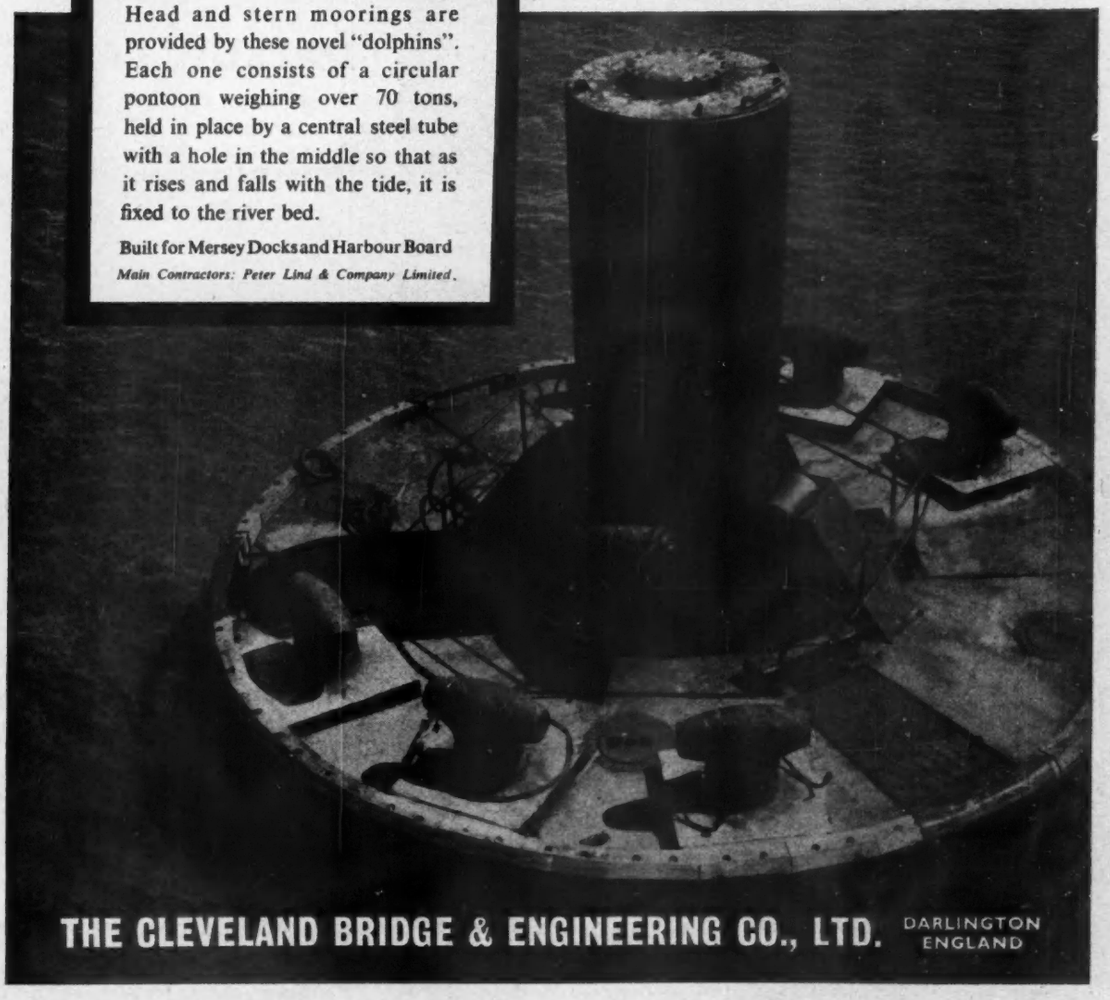
Built for Mersey Docks and Harbour Board

Main Contractors: Peter Lind & Company Limited.



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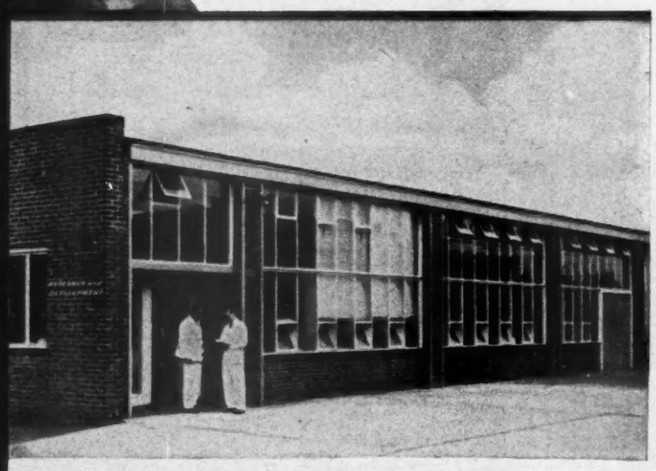

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Here we examine the behaviour of the many forms of industrial dust providing the basis from which our engineers improve designs and devise and construct new equipment to answer new problems.

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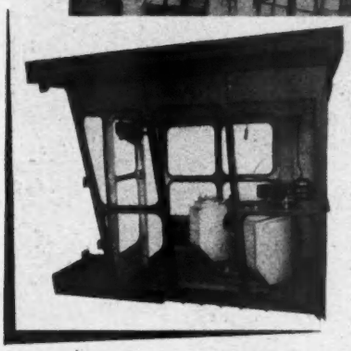

★ *a view of the cab showing the seat control unit.*

The Adamson 50/10 ton crane is the third of a series of new design supplied to Richard Thomas & Baldwins Limited, Ebbw Vale Section. Features of the crane include monolithic construction of the crab and the elimination of castings by mild steel fabrication of the hoist barrel and bottom block. The cab is of particular interest as it incorporates the most modern type of seat unit ensuring maximum visibility and ease of control. Joseph Adamson electric overhead travelling cranes can be supplied to all specifications including cranes suited to the most exacting 24 hours-a-day process work.

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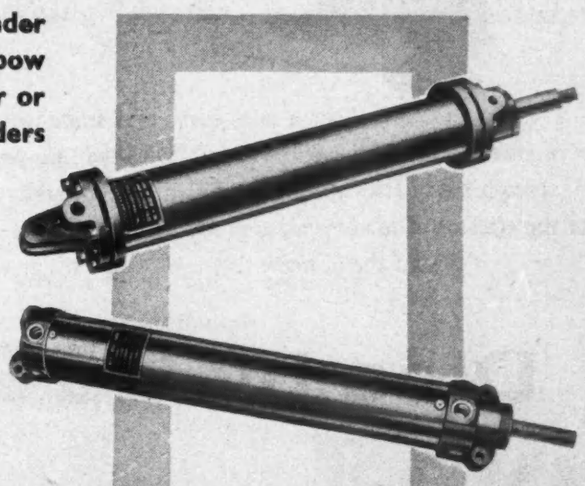

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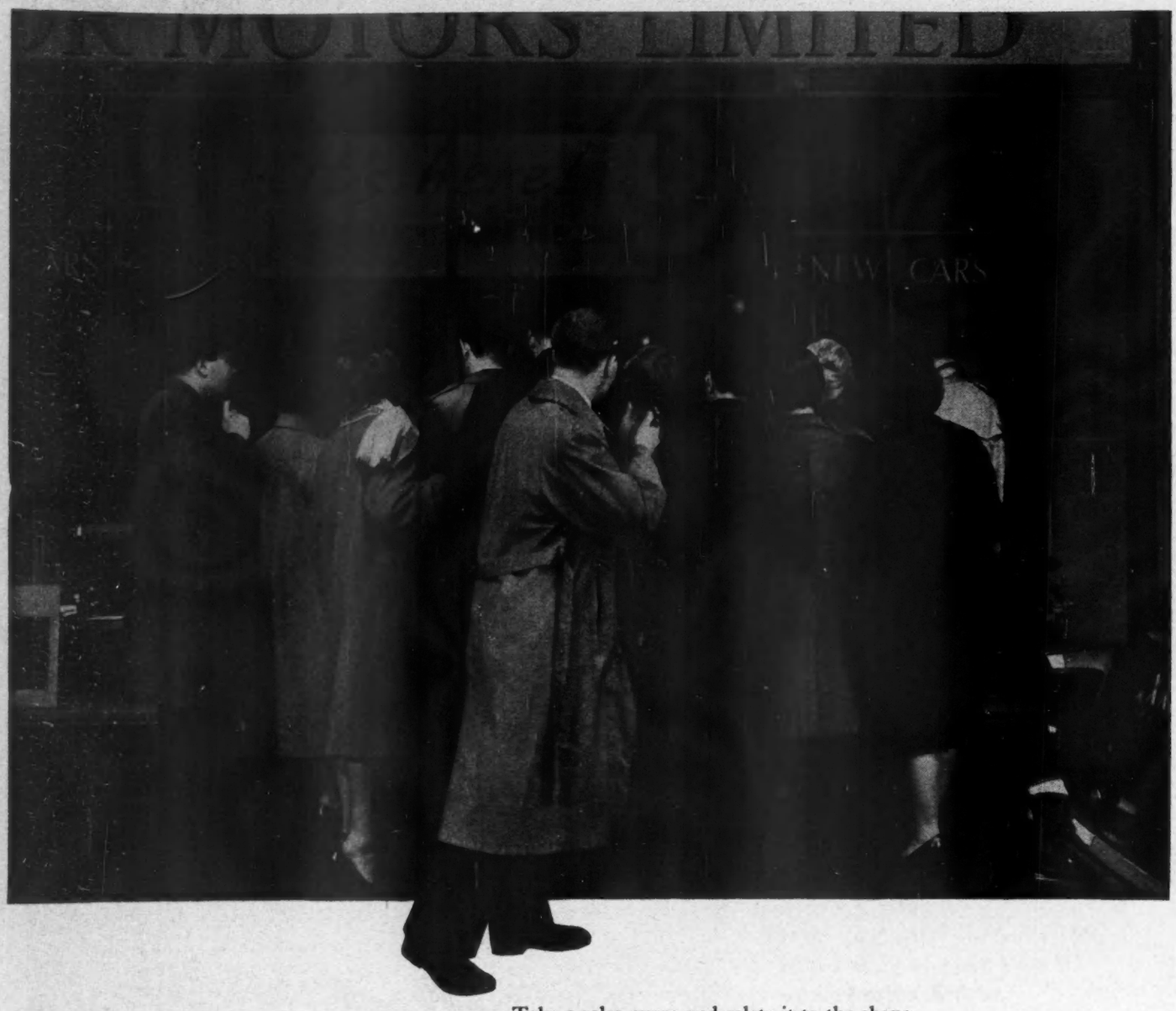
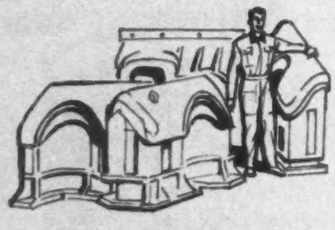


Take a sales curve and relate it to the shape of your new product. Perhaps dies come into it. Dies that are precise though large. Dies with a fine finish. Dies soundly constructed for dependability under the stresses of modern mass production press work. Vickers design them, make them, prove them, give satisfaction with them.



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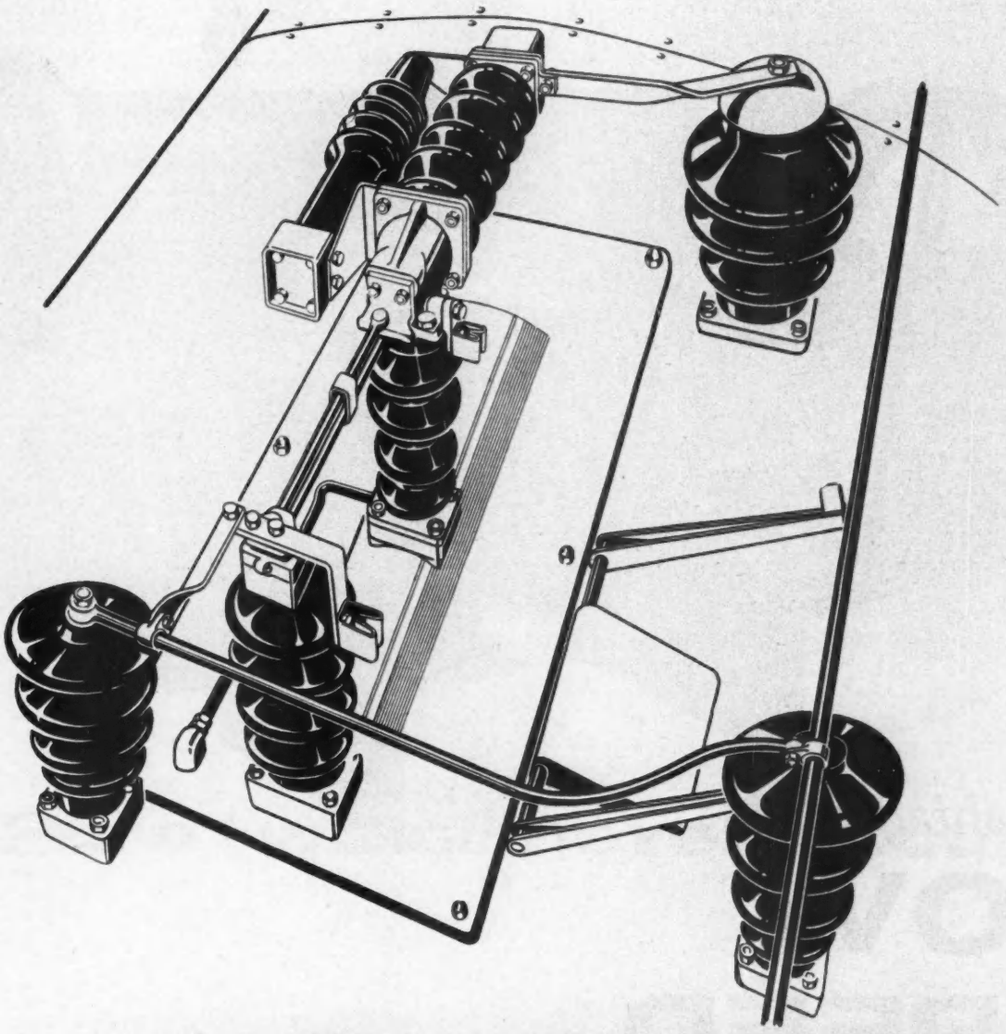

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400 amperes current rating.
250-MVA breaking capacity at 25 kV.
Compact and robust construction.
Simple six-bolt fixing to roof of cab.
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Operation from locomotive's compressed-air system.

Reyrolle

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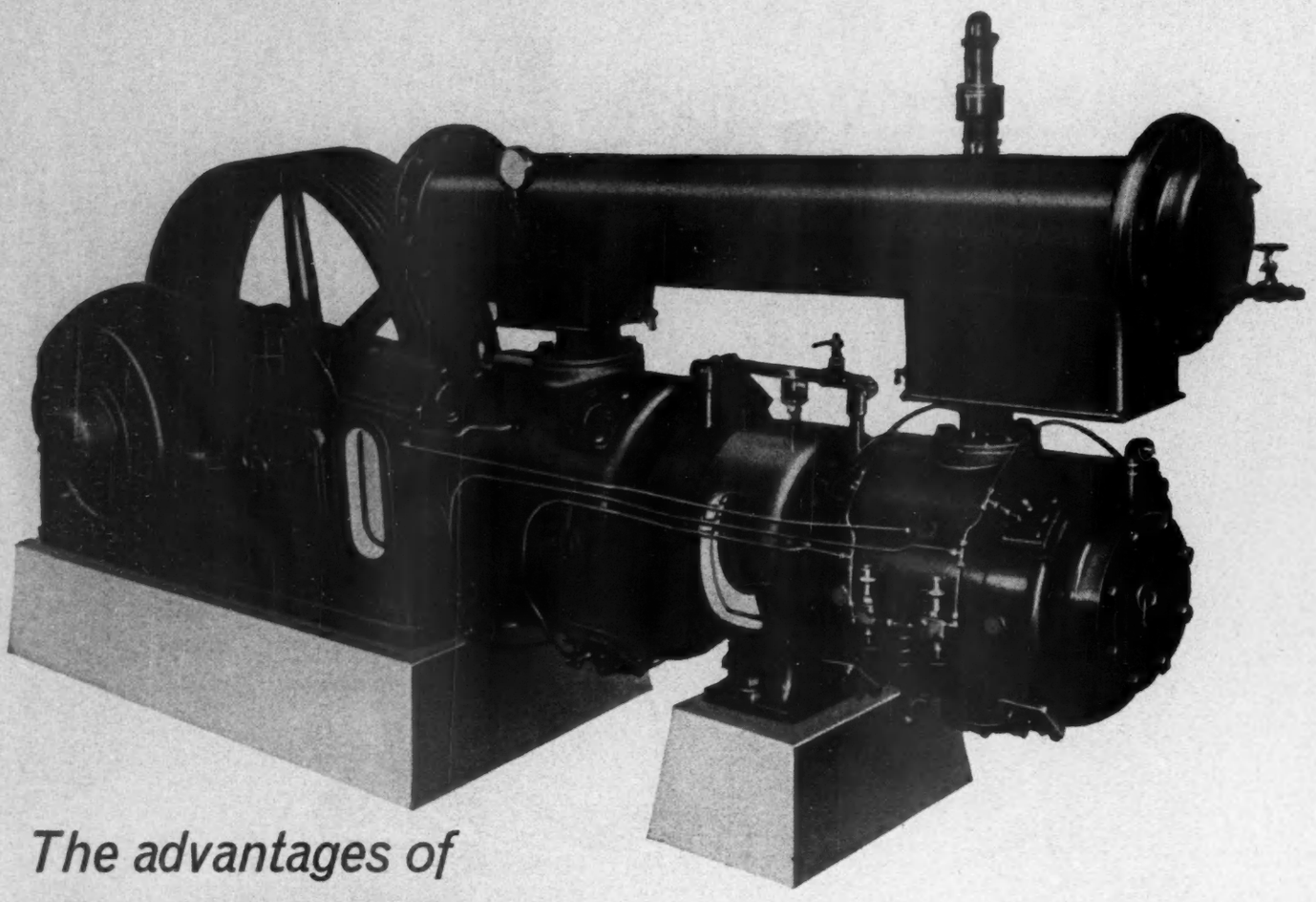

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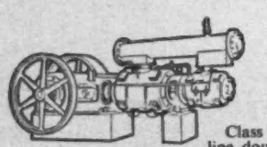
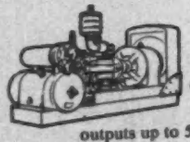
Running at speeds down to 300 r.p.m., as either single or two-stage double acting units, they have low valve velocities and ample bearing surfaces, enabling them to be operated continuously 24 hours a day with no more than routine attention.

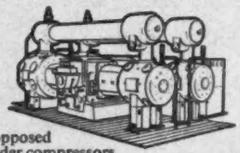
THERE IS A CP COMPRESSOR FOR EVERY TYPE OF DUTY



Class T straight-line, double-acting, single and multi-stage compressors for outputs up to 745 c.f.m. or pressures up to 2,500 p.s.i.



Class RE electrically driven Rotary Air Compressors for outputs up to 510 c.f.m. at 100 p.s.i.



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Class P two-stage air-cooled compressors for outputs up to 477 c.f.m. at 100 p.s.i.

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John-Thompson-Kennicott supply plant for the treatment of cooling waters, and for boiler feed requirements, Kennicott De-ionisation and De-aerator installations are working in all parts of the world.
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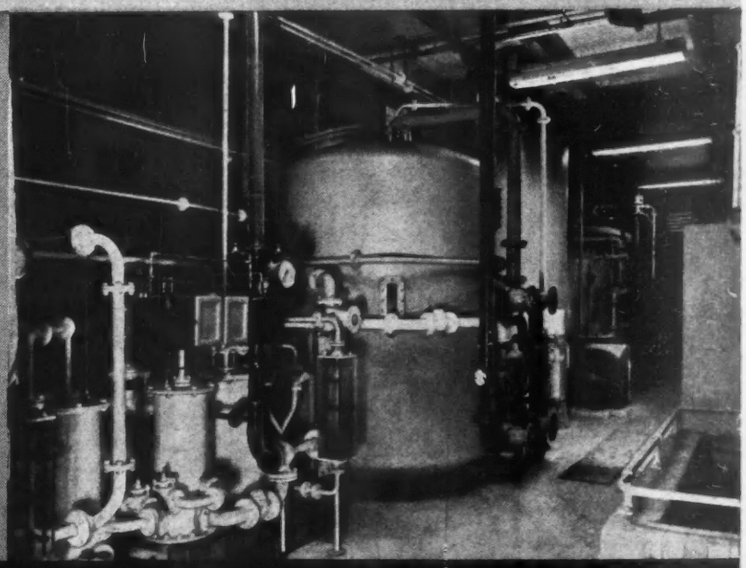
** The illustration shows de-ionisation plant at North Wilford Power Station producing 75,000 gallons of treated water in 14 hours for high pressure water tube boilers.*



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Improvements all round — that's the New Radicon exciting story! Better thermal ratings — better mechanical ratings — better casing design: all play their part in pushing up the load carrying capacity, to give you greater scope of application — to help you cut your costs by reducing size of unit for the job! Send for the New Radicon Catalogue right away — see what the latest models can do for you!

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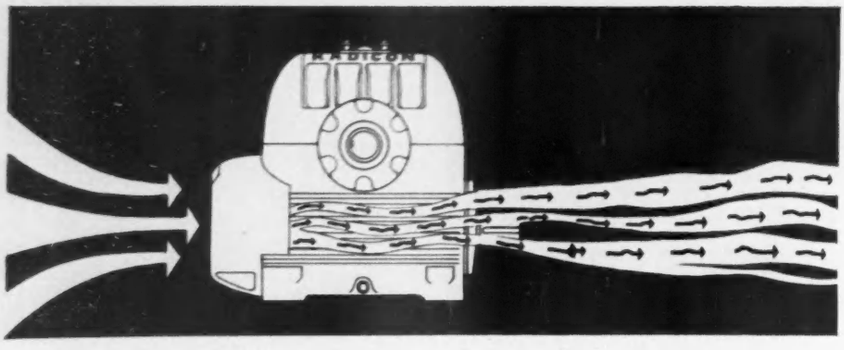

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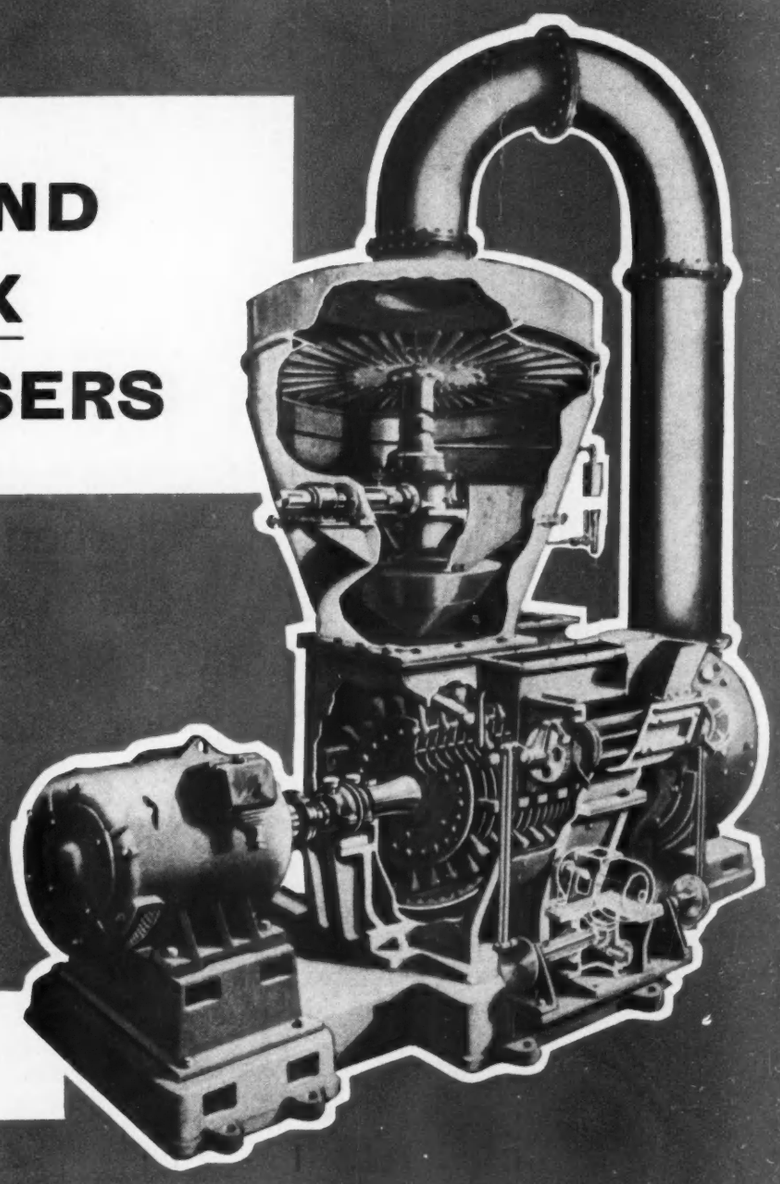
RAYMOND IMPAX PULVERISERS



Sectional view of No. 70 Raymond Impax Pulveriser

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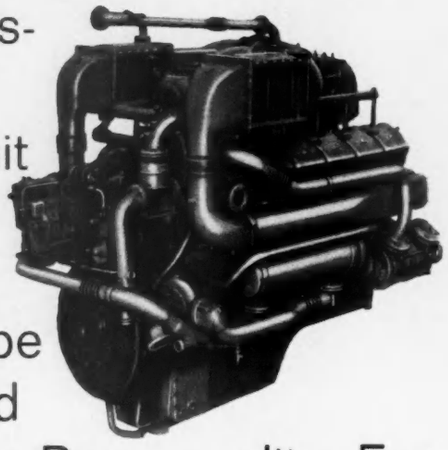

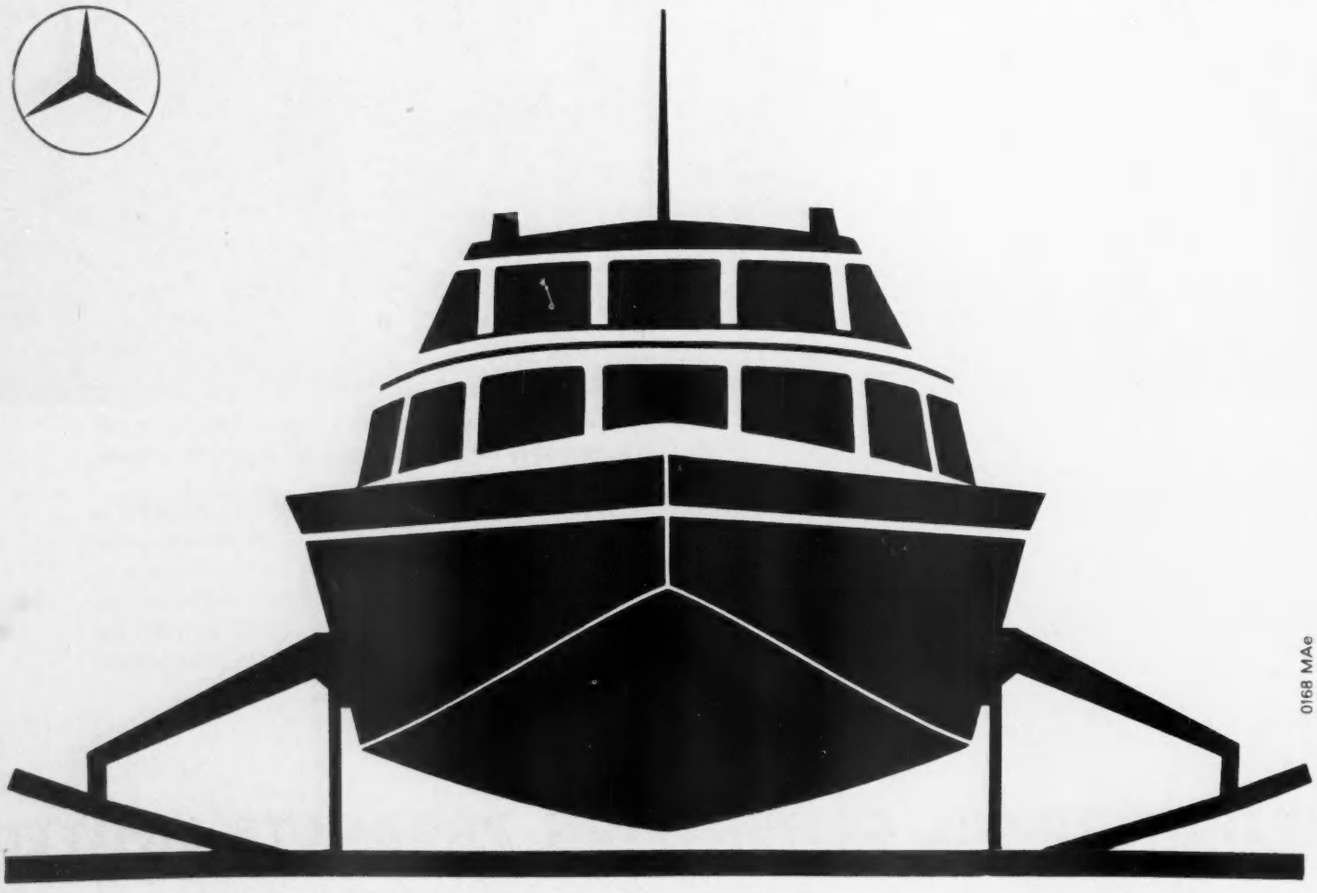

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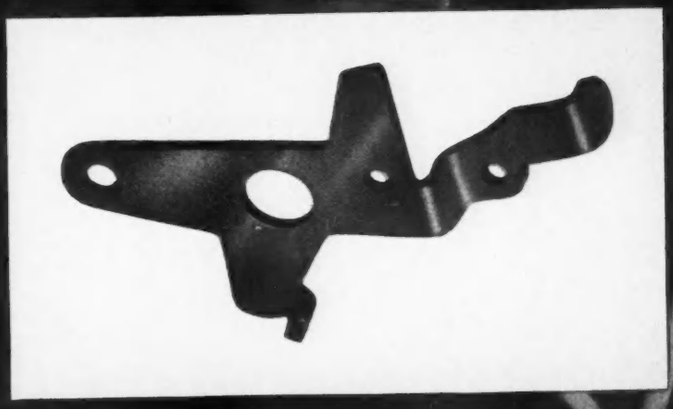

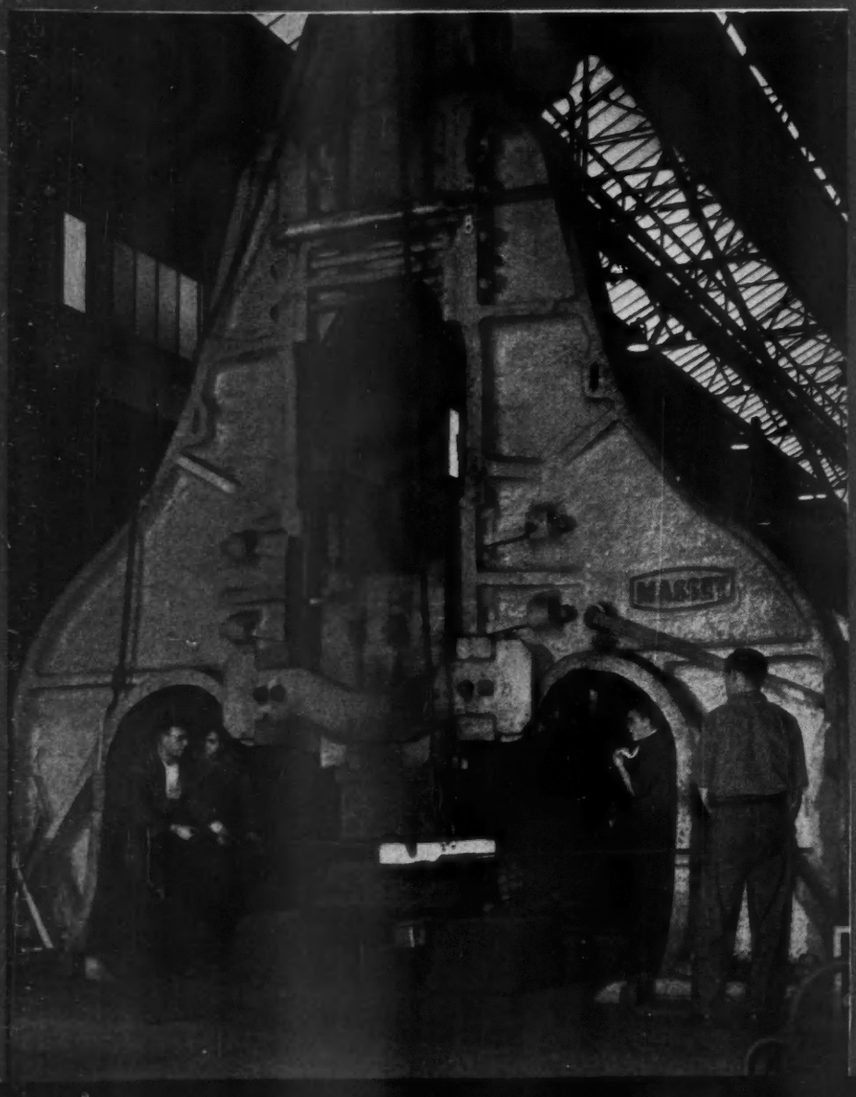

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Carpet mountings are fitted under the 4-ton Massey hammer in the photograph, reproduced by courtesy of Jessop-Saville Ltd., Sheffield. Contractors for the foundation: Wellerman Bros. Ltd., Sheffield.

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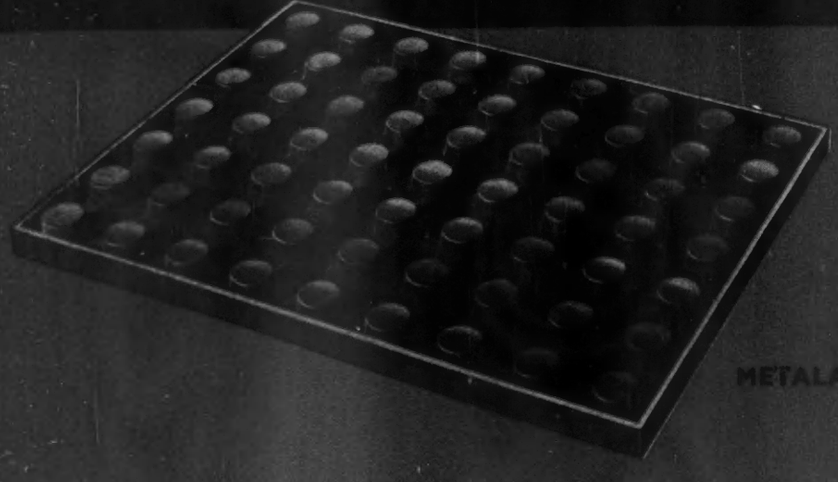

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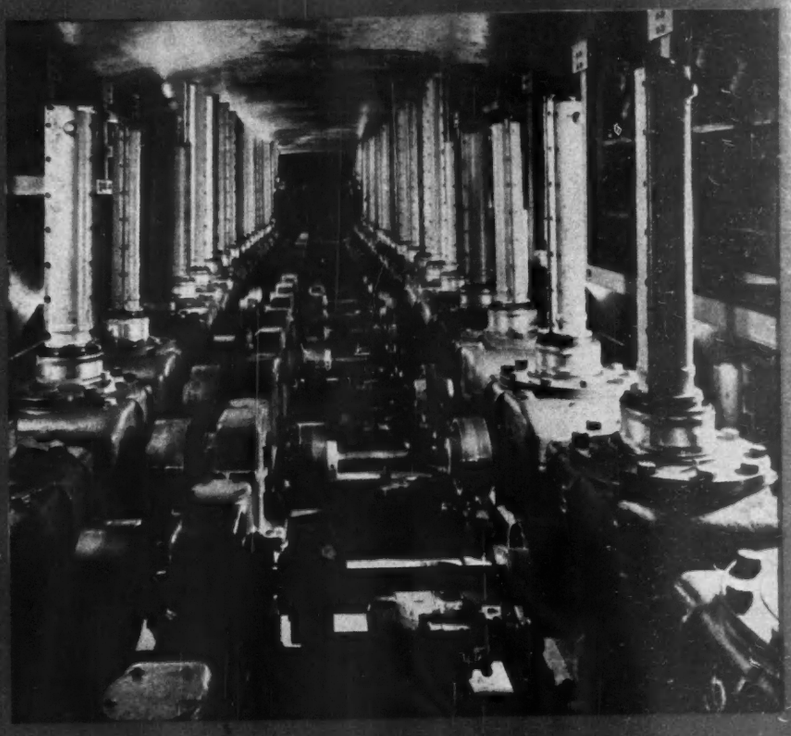
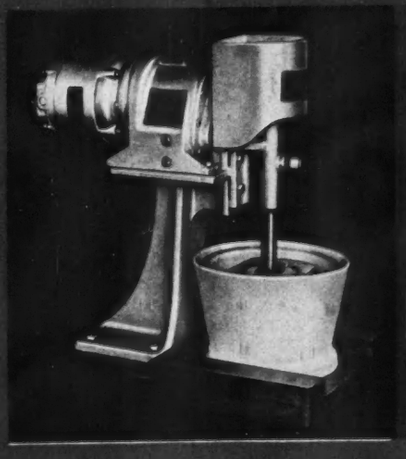
—such as supplying many special worm reduction gear units to the Royal Aeronautical Establishment for the supersonic wind tunnel at Bedford are not new to us here at Newbury, for besides non-standard units, our normal range of worm and spur units covers practically all industrial applications up to 120 h.p.



Type WGV 51 single reduction worm gearbox driven by WGV 40 single reduction gearbox. As supplied to the Royal Aeronautical Establishment, Bedford, for use in the 8ft. supersonic wind tunnel. This photograph shows part of the assembly of the working section of the tunnel.

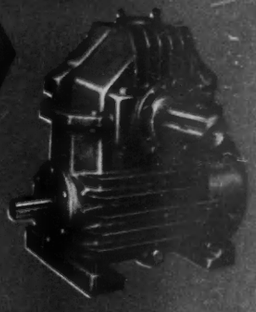
AND SMALL JOBS

—such as the production of a small gear unit for an experimental pan and muller for grinding colours is another example of our standard range. Our compact, robust helical and spur geared motors are available as double or triple reduction units in six sizes, offering a complete range of horsepowers and output speeds to the user. You can't go wrong if you specify—



Laboratory colour Pan driven by a ¼ h.p., drip proof geared motor unit, Type S.G.M.I. Ratio 22:1. Output speed 65 r.p.m. This photograph is reproduced by permission of William Boulton Ltd. Burslem, Staffs.

Type SUH horizontal shaft, fan cooled worm reduction gear. Standard sizes up to 12 in. centres; non-standard sizes up to 24 in. centres. Ratios 3:1 to 100:1.



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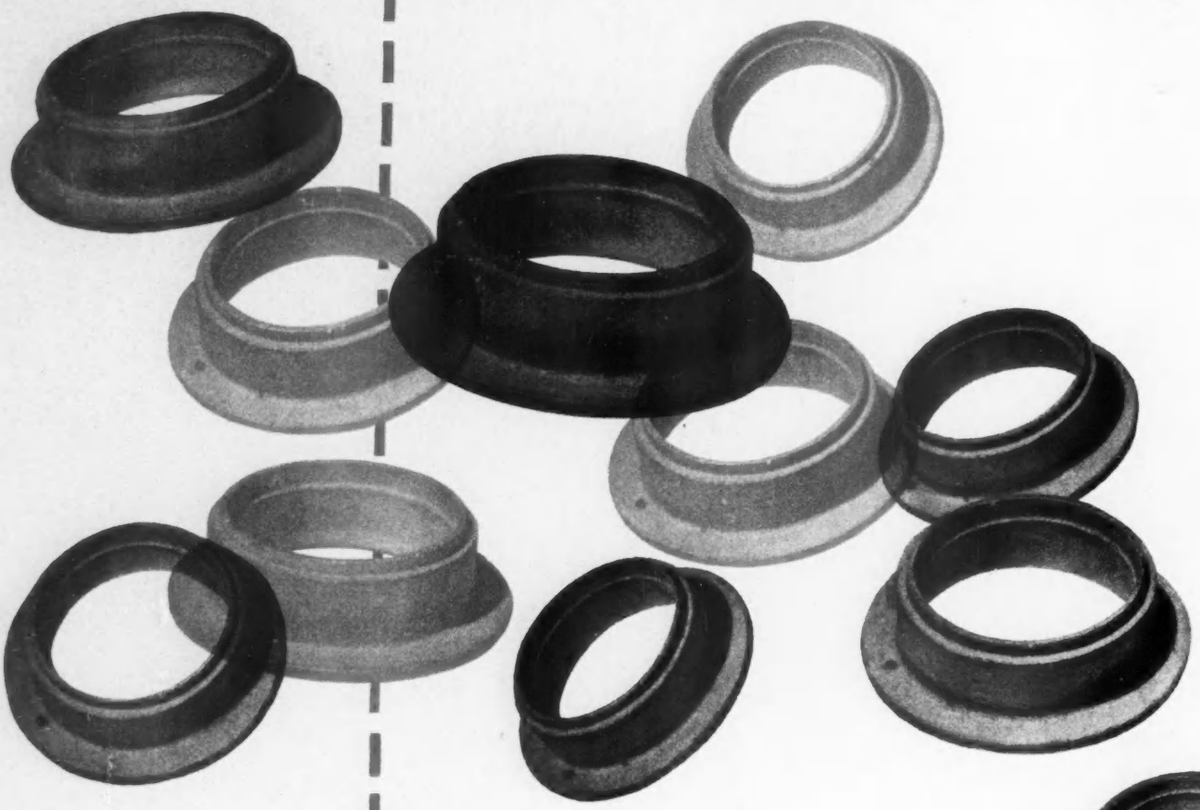
to increase output



with 40% less machining time & 12% less material used

Modern steel foundries have many techniques for manufacturing economically to a high degree of accuracy.

This Bung Bush for Brewery use was shell moulded, and showed 12% reduction in weight of material used and 40% reduction in machining time when compared with the previous production method. Output was increased considerably at less cost.

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to undertake the manufacture and supply of all Cape thermal insulation materials, Asbestos textile products etc. Only the name will change. The well known products CAPOSITE and ROCKSIL will continue to be made to the same high standards.

Cape Insulation & Asbestos Products Limited will come into being on January 1st, 1961. A few of us will be at different desks but the familiar trade names Caposite & Rocksil will still be backed by all the resources of the Cape Asbestos Group of Companies.

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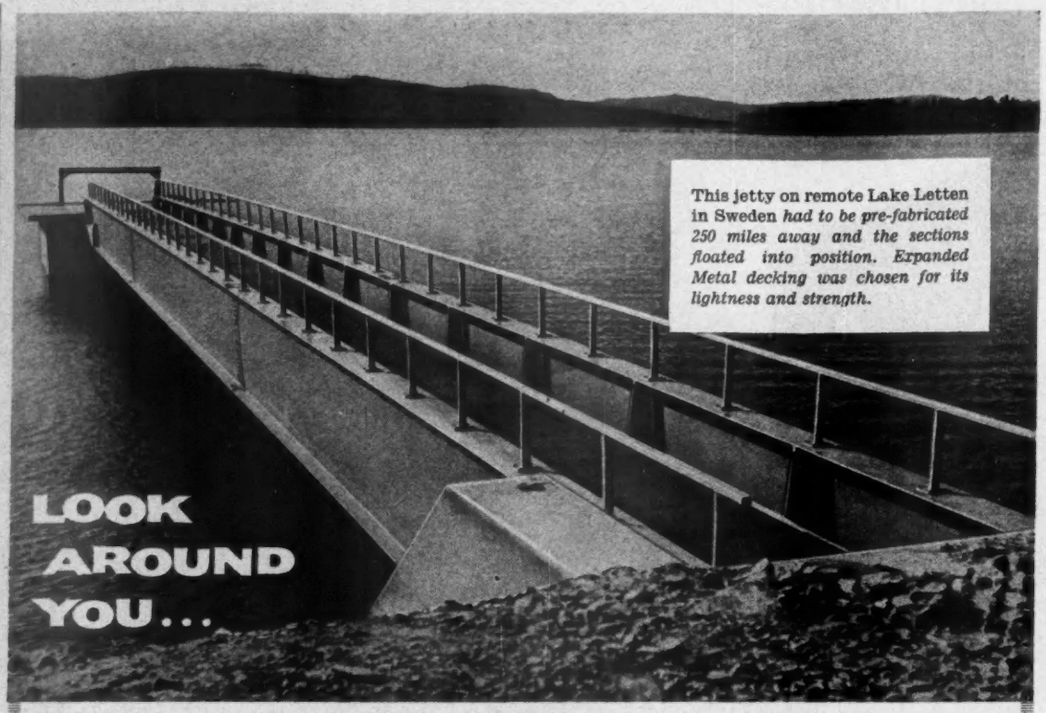
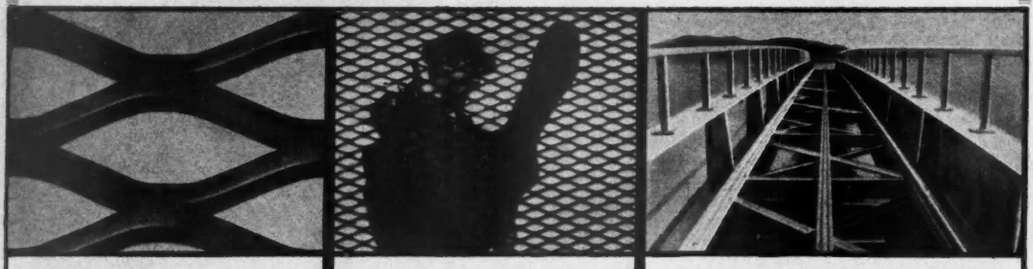


This jetty on remote Lake Letten in Sweden *had to be pre-fabricated 250 miles away and the sections floated into position. Expanded Metal decking was chosen for its lightness and strength.*

and see that on catwalks, walkways and decking Expanded Metal* provides the best solution at lower cost

* In steel or spark-free Aluminium



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'Engineering' Calendar 1961

Copies of this planning calendar—a year on a page and a reminder of the *main events* of 1961—are available *gratis* from 'Engineering', Circulation Department, 36 Bedford Street, London WC2 (Tel.: Temple Bar 3663)

Each one of the objects
in this photograph is a machine part
from which is required a
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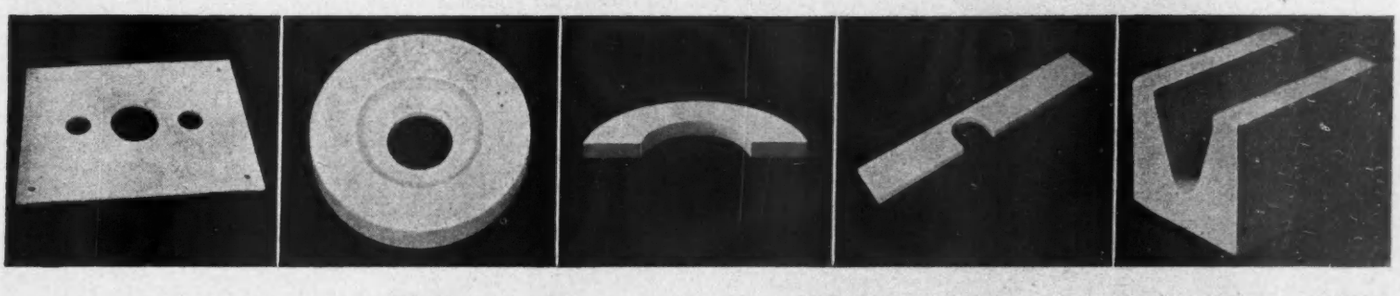
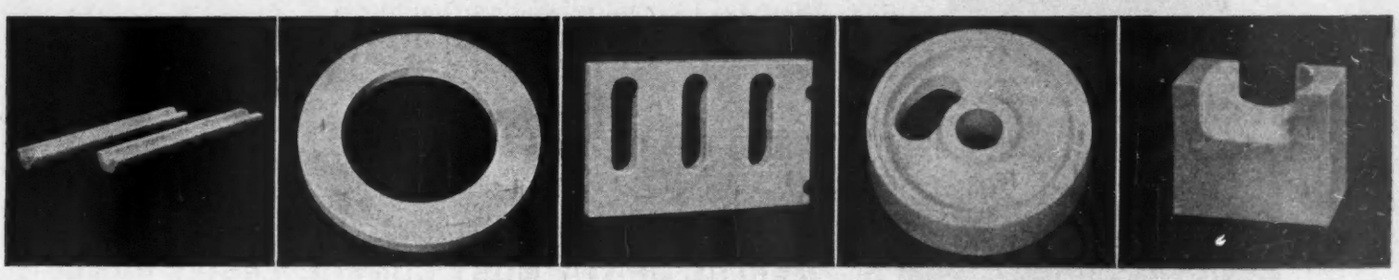
combining:
Rigidity
Strength
Low thermal capacity
Non-combustibility
Chemical inertia
Machinability



we call them "specials"



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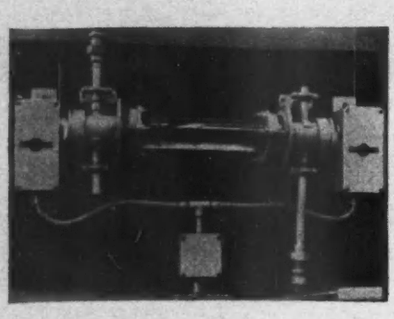

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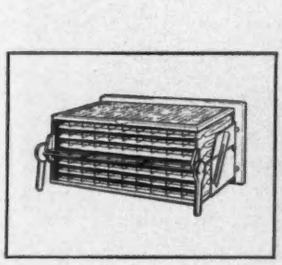

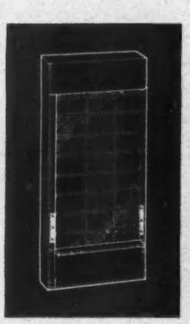

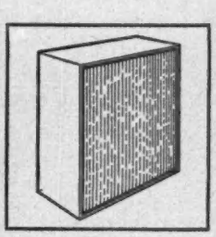

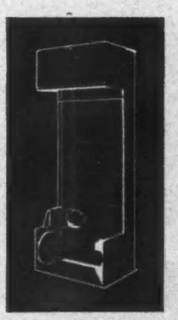

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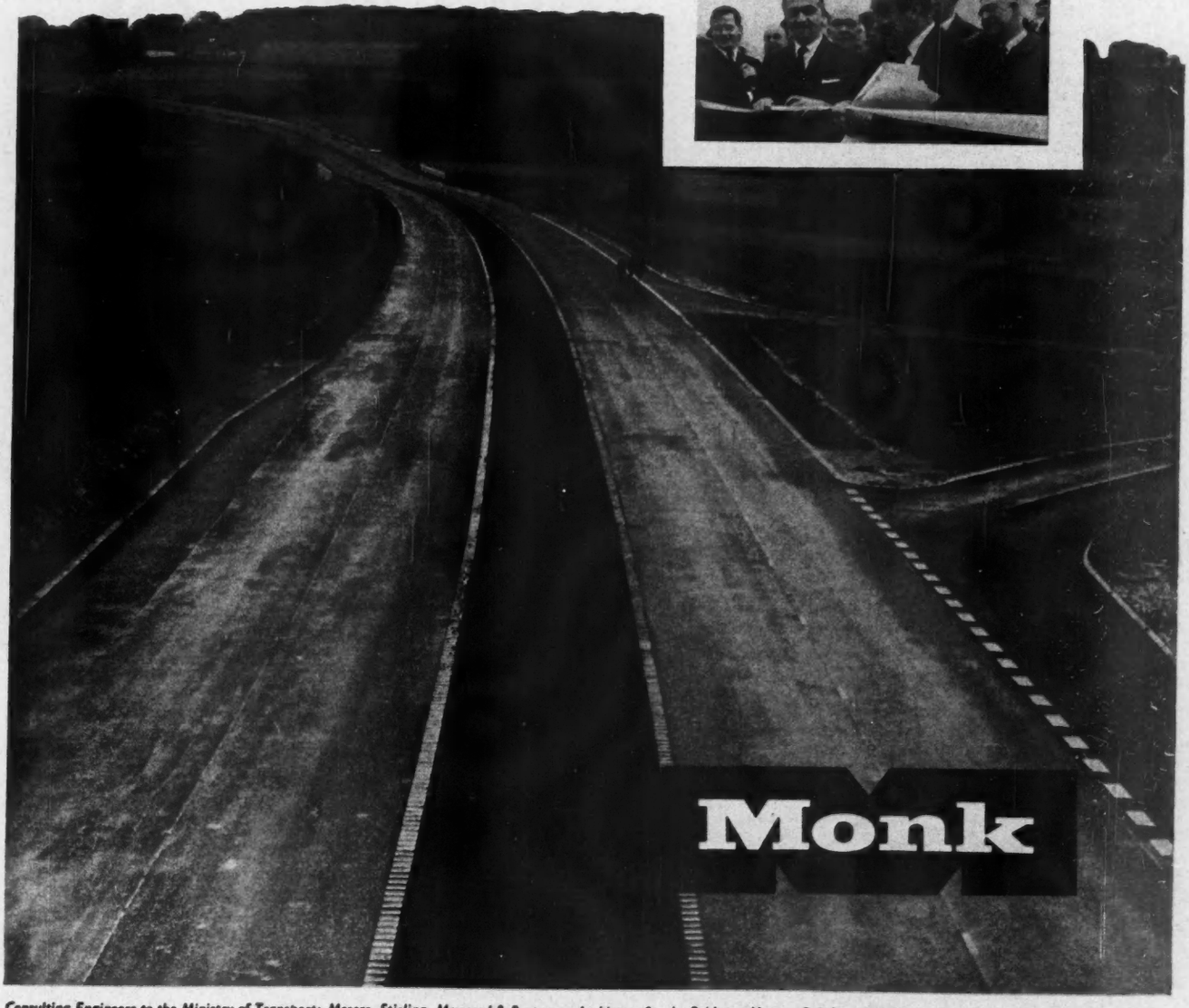

Consulting Engineers to the Ministry of Transport: Messrs. Stirling, Maynard & Partners. Architects for the Bridges: Messrs. F. J. Lenton & Partners.

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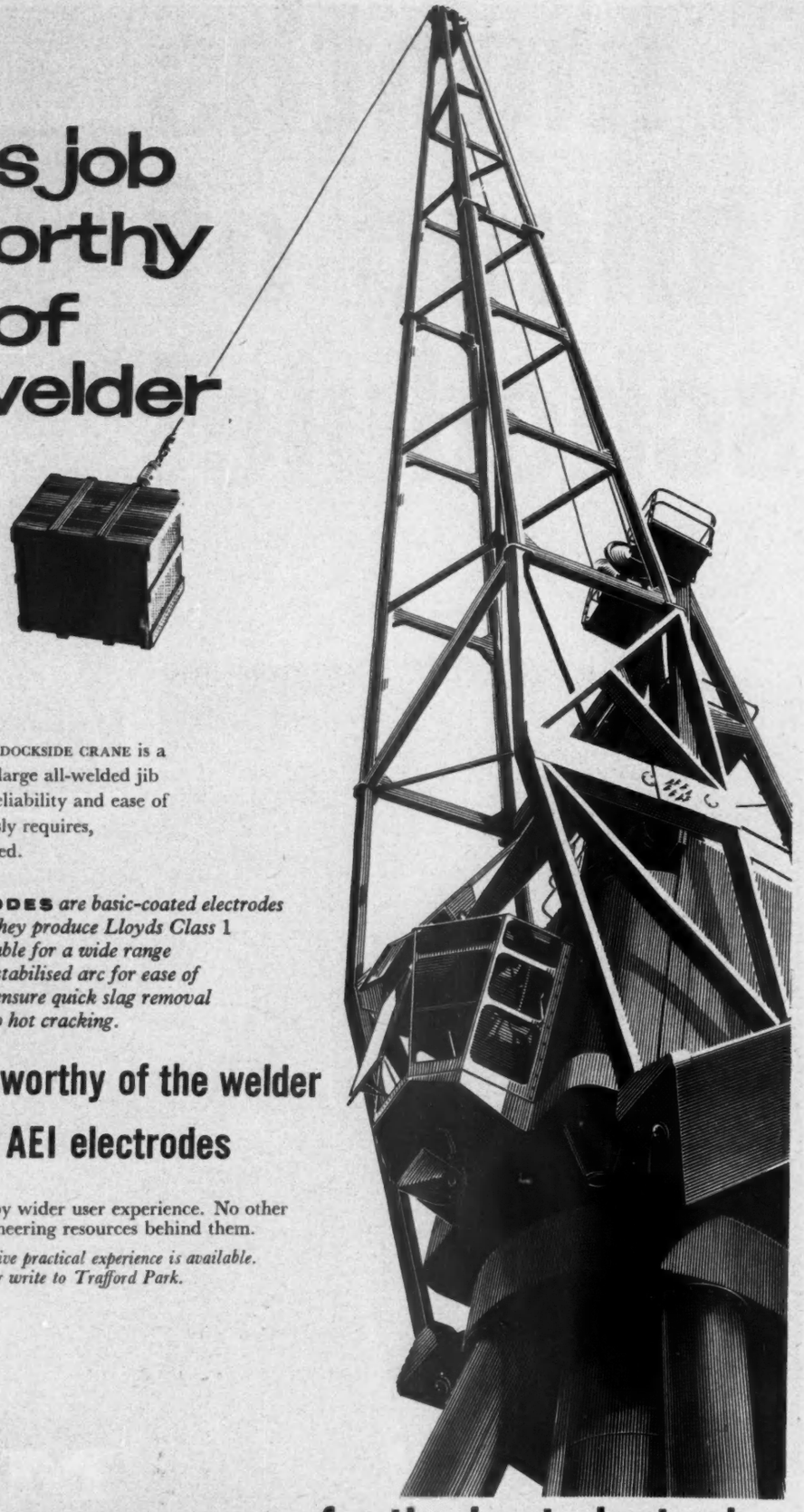

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ENGINEERING Impact

of Rising Stocks and Industrial Output

A HIGH rate of industrial production that depends for its continuance on an unusually prolonged period of stockpiling is not too likely to avoid going into a decline before many months have passed.

Looking into this vital question in detail, the current economic review of the National Institute of Economic and Social Research points out that for the first half of the year manufacturers' work in progress and stock in hand rose by around 5 per cent, or by twice as much as the rate of increase in total output. So far as is known it is believed that this rate of stockpiling increase has gone on during the third quarter.

With consumer demand expected to rise only slowly the effect of a levelling off in the amount of stockpiling by industry and the distributive organisation would be almost certain to cause a fall in industrial output. Coming after six months of almost steady industrial output (the Treasury index has been at 120 or 121 ever since April) such a development would increase unit costs to the detriment of exports.

Costs Rising

Already there is a serious position in the costs of production. In 1959, a year when wages, salaries and real earnings all rose, unit production costs fell because the output per worker increased over the year by 6¼ per cent. Now we have almost completed a year in which output per worker has fallen in many important sections of industry, particularly in the motor business, and at the same time earnings have been increasing faster than during 1959. Very few companies have claimed that by investment in new equipment or by reorganisation they have been able to absorb the extra labour costs of the reduction in the working week.

An answer to the problem is not easy to find. The National Institute of Economic and Social Research is in favour of immediately relaxing hire purchase restrictions in order to ward off the threatened recession. In effect this is proposing to apply income not yet earned to step up the volume of industrial production, thus reducing unit costs and so avoiding pricing our exports out of the increasingly competitive market.

Inadequate

On the face of it this proposal is not enough to do the trick. Even before last April, when the credit squeeze was reintroduced, the sales of some domestic appliances had begun to fall, as the electrical manufacturers have demonstrated to the Government. It can hardly be claimed that there is an air of unbounded confidence about in the country at the moment and it by no means follows that lengthening the terms of credit would bring on more than a modest rush to the refrigerator and washing machine departments or the motor salesroom.

Expanding industrial production, short of an unexpectedly rapid increase in world trade, depends almost entirely on constantly improving standards, better sticking to delivery dates and new ideas. This comes back to the newest equipment, the best machine tools, and a flexible attitude to what is to be produced.

If the Government is to be exhorted to action then a more fruitful effort might be made in trying to obtain greater incentives for the modernisation of manufacturing equipment.

Aero-Engine Industry at Parting of the Ways

One of the most exciting engineering projects is the development of an aircraft engine, a project which not only calls for leadership and team work from the highest of engineers but which in many cases since the war has been carried through with substantial overseas earnings.

Now the aero-engine industry is faced with the transformation of its financial basis. There is a major shift going on which could put the British industry in a position where its price competitiveness with the United States and Russian engine makers is nothing more than a memory.

All the major aero-engines of recent British history have been developed at Government expense against military or development contracts. Now, with the approaching end of the road for heavy bombers and with the fighter, if it remains, a totally different air vehicle to the future super-sonic airliner or the sub-sonic multi-application transport, the development costs of future engines threaten to be carried by, and accordingly to immensely increase, the cost to the aircraft constructor or the engine replacing airline.

Equal Shares

Mr. J. D. Pearson, chief executive and deputy chairman of Rolls-Royce, has recently stressed that Government financial support for the aero-engine industry is urgently needed if it is to survive. The company would apparently be satisfied with a fifty-fifty share in development costs. It is estimated that around £20 million is now the cost of preparing and launching a big aero-engine. This is much about the same as the airframe though it is a shade less risky since it is possible to sell the engines for more than one aircraft type.

That pump priming of this sort with the taxpayers' money would be plainly worthwhile is shown by the Rolls-Royce company's export earning from engines and spares of £230 million in the past seven years. The current rate of overseas earnings is almost £55 million a year.

Public money is to be put behind the new trans-Atlantic liner a project which whose success is at the mercy of the future three-hour London-New York flight and the £10 Atlantic crossing by laminar flow airliners.

Other public money will go into the dispersal of the motor car industry. There is an unanswerable case for as profitable an industry as aero-engine manufacture being given development aid. If the Government need a new committee to make the decision for them they should at least appoint it now.

of Increasing the Power of the Supergrid

The cry for a stable home market from which to successfully operate in the export fields is most often heard from wounded industrialists whose home sales are being thwarted by credit restrictions and high interest charges.

A happy exception now comes from the Central Electricity Generating Board. By adopting a 400,000 volts system for their transmission lines the CEGB give powerful support to the electrical industry in its future work for electricity boards around the world.

The move towards much higher voltage transmission lines, the first is expected in commercial use in 1965, is doubly enlightened. Not only will it help our manufacturers gain experience of special value to countries where power has to be sent much greater distance than in the United Kingdom, it will in addition reduce the number of high-voltage transmission lines required to meet the demand for more power, a demand now growing faster than ever.

Most of the existing 275,000 volt Supergrid lines were designed with conversion to 380,000 volts borne in mind. Where they are to be used for the new higher voltage they will be re-insulated. The effect will be to raise the carrying capacity of a double circuit line from 1,200,000 kW to 2,000,000 kW.

Taller but Fewer

For new main trunk lines CEGB are to bring in a newly designed tower which while it has the disadvantage of being 20 ft taller than existing towers will have the advantage of increasing the power carrying capacity of the circuits up to 3,000,000 kW.

CEGB have taken the firm decision to go ahead with the project without awaiting operating experience with the 380,000 volt experimental circuit between Monk Fryston and High Marnham, a circuit which is not expected to come into service before 1962.

400,000 volt transmission will be the highest in commercial use in any nation other than the Soviet Union, hence the leading position being made available to the British electrical industry in the development of transmission gear and ancillary equipment.

Heavy Electrical Firms in Railway Dilemma

Unenviable is a mild word with which to describe the feelings of those engaged in the British heavy electrical industry as the prospects for continued large-scale electrification of British Railways appear to grow gloomier and gloomier.

As one Press report follows another it appears that the postponement, if not cancellation, of the right-through electrification of the Crewe to London line is high on the list of trouble spots for the industry.

The British Electrical and Allied Manufacturers' Association have advanced to the Board of Trade and the Ministry of Transport their view that a fully electrified London-Crewe line would carry much greater loads, both of freight and of passengers, than could be moved by motorway, and that there is an overseas market worth at least £200 million where British electrical firms can expect valuable earnings, so long as their competitiveness is not damaged by the loss of a stable home market with the British Transport Commission.

Crewe-London

Since it is estimated that half the $140 million bill for the Crewe-London electrification would have to be spent on track improvements and replacement of locomotives and rolling stock even if there is no electrification, it seems no more than folly to drop the scheme, and with it its benefits to the heavy electrical firms, perhaps in order to do no more than strike some hypothetical balance with the road programme.

The jibe has been levelled at the Minister of Transport that he is no more than merely a Minister of Road Transport. A Government White Paper is expected before the end of the year on railway policy. If it is seen that the substance of British Railways modernisation—and that means electrification—has been maintained, and not buried in lip service, then the manufacturers concerned will be able to go full speed ahead with equipping the United Kingdom with a first class national rail service, and with bringing home some very useful foreign earnings.

and 33,000 Leave Britain for Life in Australia

Whatever the difficulties in introducing suitable foreign workers to British industry there is no doubt about the resumed strength of the flow of emigrants from the United Kingdom to Australia.

At the end of the year, it is now estimated, some 33,350 people will have been assisted with their passage as migrants, the largest number since the record (38,000) was set up in 1952.

The official Ministry of Immigration target for the financial year 1960-61 is 34,000 and there is now confidence in Canberra that this will be reached. Over the next three months it is believed that 12,000 people will sail from British ports, using every available berth in 13 ships.

The Australian need is curiously linked to that of the United Kingdom. Expanding the industrial production, and the productivity, of UK industry needs many more skilled men than are available here. The growing manufacturing industries of Australia, the steel industry, electronics, petroleum, chemicals, the process industries; it is a long list of fast developing industry for which skilled and to some extent semi-skilled men are needed.

Confidence

Perhaps one of the great attractions that is filling the emmigrants' ships is not the sunshine and the beaches but the confidence. Britain trembles on the brink of the European Common Market, its Opposition is in one long crisis, there is not much need of higher education to understand that high money rates raise the reserves and the cost of living and do nothing but harm to the alarming round of declining exports and a widening trade gap.

It would be absurd to begrudge Australia its flow of new blood. It is a sad day that we have not a great national programme for training and absorbing all the hard working and needy Spaniards and Italians who could be encouraged to settle in Britain.

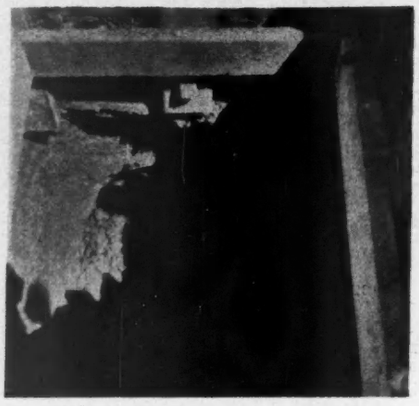
Pipe Wrap Tapes—a New One and an Application

Permacel Tapes report that considerable interest was shown in their pipe wrap tape which was exhibited at Olympia at the Corrosion Exhibition. It is still very early days for these materials in this country although two other firms, Gosheron and Minnesota Mining, have been paving the way by getting contractors to try their tapes. The little but increasing interest in these materials has been built around pvc, because this plastic is the basis of those produced by the last two firms. But the one by Permacel is different, if only to the makers. It is in polyethylene.

The fact that protective tapes for under and above ground are being offered in more than one plastic should not be too confusing. So far as the end user is concerned there is little to choose between them. But it is worth noting that thickness for thickness, the polyethylene tape is more conformable than the pvc one, yet has lower abrasion resistance. Since they cost the same as pvc ones, the most straightforward advice is to try polyethylene where there are pipes above ground, and rely on pvc for underground usage.

John Gosheron are pleased at the recent application of their Polyvil PP pipe wrap tape in a water main laid by the Colne Valley Water Company in Watford. This shows with little doubt the high resistance of these coatings against abrasion. The 30 in diameter water main, comprising lengths of spun iron pipe, had to cross the Watford By-Pass which is a feed road for the M1. It had, of course, to go underneath. So a 60 ft long steel pipe—of 6 in greater diameter than the spun iron ones which would subsequently be laid through it—was pushed through a hole under the road immediately following the trailing edge of an augering drill used to make the hole. In the illustration you can see these appearing at the far side of the road in a trench. By this method, there is no risk of subsidence before the lining pipe is pushed through. Now the crux of the story is that the 36 in steel liner tube was prewrapped with pvc tape made by Gosheron; and this is the only protection that will ever exist. The reason why tape was used was that normal bitumen coverings would almost certainly have been damaged in being pushed through behind the auger.

Subsequent checks on the lining tube after completion of the augering process showed that the Polyvil P.P. sheath had suffered no damage. The whole operation was carried out by William Press and Son under direction of the Colne Valley Water Company.



Steel pipe wrapped with pvc tape appears at far side of road just behind augering drill.

Permacel Tapes Limited, 260 Bath Road, Slough. Jonn Gosheron and Company Limited, Albert Embankment, London, SE11.

Polypropylene Will Not Often Replace Metals

ICI men seem to thrive on a challenge and this time it's one which they made to themselves: to build a full-scale plant for production of polypropylene in 16 months. A typical understatement conceals their pride in meeting this—"... it was an almost impossible target. However, it was achieved."

So the plastic material, about which a lot of truth and an equal lot of bunk has been written is now here ready for moulders to offer for anybody who wants something made in it, no matter how large the quantity. Since May, 1959, the Plastic division of ICI has been developing the UK market for polypropylene, mostly obtained from abroad. Shell Chemicals, performing similar tactics, are also well on the way to having a plant in operation and theirs should be on stream in late 1961.

Plastics are pretty amazing materials and the growth in output of the industry is very high—at around the 16 per cent mark per year.

It is true that plastics have caused a minor revolution in domestic ware, but it is irresponsible to suggest that there will ever be large-scale replacement of metals by these thermoplastic materials in structural engineering applications. Nylons, the new acetal plastics called Delrin, and polycarbonate, the last two of which are not yet being made in the UK, will undoubtedly challenge zinc, magnesium and aluminium diecastings, but only where these are carrying low stresses, or where local high stresses such as occur on gear wheels can be distributed over a wider area in a plastic component because of its flexibility.

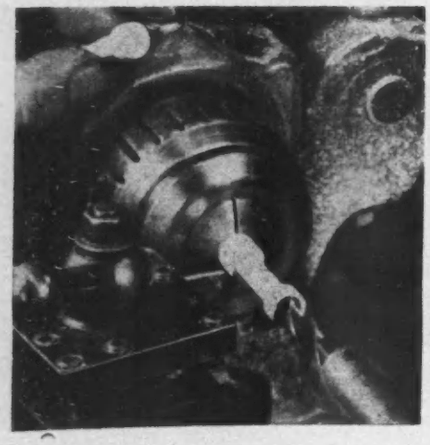
Polypropylene, to all but the plastics expert or the person who insists on boiling his articles in water, will appear similar to high density polyethylene. Density is of the same order—0·90 to 0·91 gm per c.c.; tensile strength is likewise of the same order—with a top limit of about 5,000 lb per sq. in; Modulus of elasticity is a few per cent higher but still only one-two-hundredth that of steel; and coefficient of linear thermal expansion is almost identical in being ten times that of steel. Remember, of course, that density is an eighth that of steel products; but even if you turn all the properties into ones relative to density it still doesn't make sense in terms of bulk of material needed in a stressed component.

ICI, even after the foregoing run-down, should not appear to have made a wrong decision. Expansion of consumer outlets for plastics such as in refrigerators and domestic equipment will easily take care of their 11,000 tons a year capacity, and also Shell's 15,000 tons. Note that although it will withstand boiling water, it is unlikely to achieve approval for hot water piping where there is any pressure; also its high thermal expansion combined with its low strength at 100° C results in droopy installations.

Fibre manufacture should take quite a lot of the output of polypropylene as it has good strength and low cost. Tenacity of monofilaments at around 6 gm per denier is similar to the figures for industrial nylon and Terylene filaments, and with polyethylene, which is already being made into ropes in the UK, it shares the unique property of floating on water.

Imperial Chemical Industries Limited, Millbank, London, SW1.

Boron Nitride—an Inert, Machineable Ceramic



Boron nitride is a cermic which has some unusual properties, the main one of which is its price. It is worth knowing of, but could be forgotten with advantage by 99 per cent of engineers. For those who are looking for a material which answers the following descriptions, it is worth noting that British Ceramic Research Association are performing a very useful investigation into its properties, and that it can be obtained from Carborundum Company in the USA.

Carborundum describe boron nitride as "an easily machined, impermeable ceramic material with unique electrical and corrosion resistance properties for use up to 3,000° F." The claim for machineability is unusual, and might be useful.

While being inert to most organic solvents and many corrosive chemicals, boron nitride resists the attack of such materials as molten iron, silicon, aluminium, cryolite, copper and zinc.

Boron nitride is easily machined with steel cutters.

It is said to resist chlorine attack up to 1,300° F, but begins to oxidise in air above about 1,400° F. Strength is not very high in articles made so far, flexural strength being quoted as 16,000 lb per sq. in. It has a remarkably low thermal expansion rate of $0{\cdot}3 \times 10^{-6}$ per ° F which combined with low modulus of elasticity, makes it resistant to thermal shock.

British Ceramic Research Association have this to say of the material: Crucibles for melting silicon have been made by cold-pressing the powder and firing this in nitrogen, but where higher strength is required, hot pressing must be used. As a refractory machineable electrical insulator it has been found suitable for making spacers for use in high temperature furnaces. It forms an ideal electrical insulator in conjunction with graphite because of its similar thermal expansion.

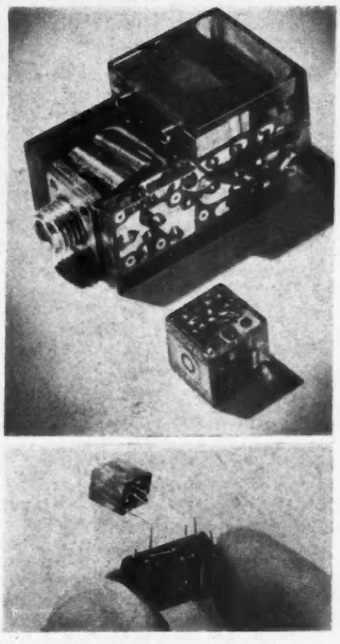
British Ceramic Research Association, Penkhull, Stoke-on-Trent.

Carborundum Company, Niagara Falls, NY, USA.

Potted in Epoxy and Silicone Rubber

A microminiature preamplifier unit, no larger than a 0·5 in cube, has been produced by McMichael Radio for use in telemetry equipment. The unit is encapsulated in Araldite epoxy resin, which according to CIBA enables use of very fragile components in a much smaller assembly giving a higher input impedance and lower input capacitance than a unit produced by normal techniques. In the top of the illustration can be seen the preamplifier alongside its much larger predecessor.

Ardente Acoustic Laboratories also have great skill in making sub-miniature amplifiers; but



for one of their products at least they use a quite different potting compound—Midland Silicones' cold curing silicone rubber. The small size of one of their units—the Minerva hearing aid amplifier—is encapsulated in this material as shown in the lower illustration. The main difference between this and epoxies is the resilience, which is useful in this instance if the hearing aids are accidentally dropped.

CIBA (ARL) Limited, Duxford, Cambridge.
Midland Silicones Limited, 68 Knightsbridge, London, SW1.

Build in Comfort in a Nylon Airhouse

Hampton House Developments are using a nylon igloo, a huge 50,000 cu. ft airhouse with no visible means of support, to ensure that work will be able to continue whatever the weather conditions. The builders will be able to carry on in spite of rain, hail, snow or sleet.

The nylon airhouse is still an unusual new idea in Britain and this is the first time that one has been used for a purpose such as this. It consists basically of lightweight but immensely strong skin of coated nylon fabric held up solely by a constant supply of low pressure air.

Erection is simple. The airhouse is laid out on the ground in sections which are zipped together and the base ring is pegged down. Air is then pumped in by fans and the structure inflates within a few minutes. It is maintained erect simply by keeping the fans running. Costs are low, as a 5,000 cu. ft per min fan, for example, costs less than 2*d* an hour to run. Nylon airhouses have excellent stability even in high winds.

The airhouse beneath which the house at Hampton is being built has one centre section and measures 70 ft by 40 ft by 20 ft. It was not produced specially for the job. Airhouses intended specifically for construction work of this type would be somewhat higher. They would also incorporate a more suitable entrance than

the flap-over doors on the side. Experimental work by the manufacturers, Gourock Ropework Company, suggests that there would be no difficulty in providing an air-lock doorway large enough to admit a small lorry.

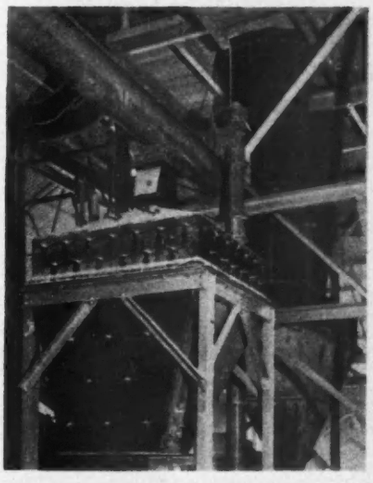
British Nylon Spinners Limited, 68 Knightsbridge, London, SW1.

PVC Coating Replaces Natural Rubber

Watts Blake and Bearns, of Newton Abbott, have recently had the cyclone chimney and hopper of their china clay pulversing and drying machine lined in pvc by Plastic Coatings. Besides the corrosive effect of sulphur trioxide fumes, the chimney has to withstand erosive attack by clay particles.

Natural rubber lining was previously tried, but had to be abandoned because of poor ageing properties. Vylastic paste, based on pvc supplied by British Geon, does not age so quickly and provides a coating with excellent corrosion and abrasion resistance while sticking pretty well to the substrate metal.

At the same time, pvc coating has cut costs: not only is it cheaper than rubber lining, but as both internal and external surfaces are coated,



Watts Blake and Bearne expect to avoid the need for lagging the chimney, thus achieving a double saving.

Lagging this chimney was previously necessary to ensure that the temperature inside the chimney did not reach dew point before clay could be packed.

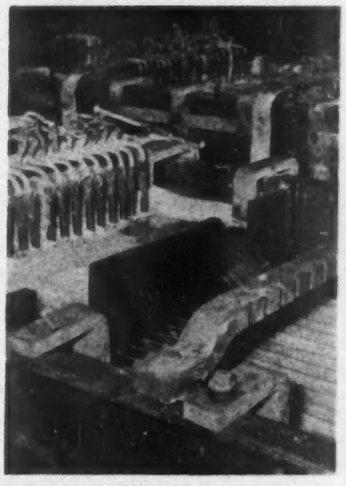
Plastic Coatings Limited, Guildford By-Pass, Surrey.

Impregnated Plywood Withstands Hot Acid

A demonstration of the properties of Permaply, a resin-impregnated plywood made by Venesta Plywood, has been reported by Rylands Brothers of Warrington. Rylands, one of the UK's largest manufacturers of galvanised steel wire, are now using plywood extensively in galvanising equipment in which it is exposed to highly corrosive chemicals.

First use of Permaply by Rylands was for covering tanks holding zinc sulphate solutions at temperatures of between 140 and 200° F. Wood covers used previously perished and flaked after a few months' use, the flakes dropped into the solution, and the equipment had to be shut down for cleaning as the pipes became choked. These were replaced by covers formed from single sheets of Permaply ¾ in thick. Some of these have now been in use for several years without showing signs of trouble.

In galvanising or plating cells 1 in thick Permaply was put in direct contact with hot sulphuric acid (a 14 per cent solution held at 140 to 170° F). Ebonite sheeting used formerly softened and buckled and was expensive to replace. The chemically treated plywood, Rylands have found, will survive a minimum of



six months in contact with the acid before needing renewing.

Venesta Plywood Limited, Queen Street Place, London, EC4.

Inert Plastic Film Can be Cement

A new Teflon fluorocarbon film which can be cemented with common adhesives is now being made in development quantities by Du Pont. This is made from fep, a relative of ptfe, and it shares the same good antistick and chemical resistant properties. It is available in development quantities in widths up to 30 in from 1 to 40 mils (0·001 to 0·040 in) thick.

Its main use will be for chemical resistant linings but it is best to understand the apparent limitations. What, for instance, will happen at joints? Unless the film can be welded to itself it will be impossible to prevent attack on the adhesive cement; chemical resistance of the lining will then be reduced to that of the adhesive system. Unlike ptfe, this film material can be heat sealed, but it will still need tooling up for high frequency welding or roll seam welding if this aspect of joints is taken seriously. If it is not, there is no point in choosing this expensive material for a lining at all.

Du Pont de Nemours International, S.A., Geneva, Switzerland.

Plain Words

By Capricorn

WHY do people send me calendars at Christmas? We shall all be sending and receiving them soon. They will come in all sorts of sizes and shapes, all equally ill-equipped for hanging on a wall. They will come in various colours with a vast array of subjects and treatments. There will be the old-fashioned solid sort, all figures and black letterpress. There will be pictures and drawings to appeal to the engineer. And the more lascivious pictures and drawings to appeal to the id.

Why do we do it? Do we really think that our calendar will get us any more business from a hard-boiled buyer than the other chap's? We know that lots of other people are doing it so what are the odds, on any reasonable basis of probability, that our's will be the lucky one chosen to be hung, collect dust, and be doodled on perhaps, for the rest of the calendar year? Does our friend really care on a filthy Monday morning in February, as he chalks off the date with the stub of a pencil and desperately notes that he has got to wait six more months before he goes on holiday, that he has us to thank for being reminded of the fact? Will it make him think that our nuts and bolts or our engines are any better than our competitor's?

Perhaps it is all to do with status symbols on the part of the sender. The bigger your company the larger the calendar, the more the varieties of tone and colour and the further removed from straight selling. Is there an unwritten code somewhere that when your operatives pass 100,000 you switch over from lists of products in black and white to nature scenes in colour, and when you get to 150,000 you graduate to pretty girls in very little at all? More probably you start with the pretty girls and end up with nature scenes.

Perhaps it is the other way round. Perhaps we are less travelled biologically than we think from our ancestors who painted on cave walls. Do we all have a secret urge to put up stimulating slogans on our office walls like "Think," as one well known American company did throughout its works? Do we all want to put the family photographs on our desks but haven't got the courage?

Here at Christmas time comes the vehicle of escape. We really want to have them sent to us so that we can work off this repression and get something up on that wall, as generations of cave men have done before recorded time.

Yes, I am looking forward to those calendars coming. They give a great deal of pleasure. When I make my selection, I shall reflect that the calendar is man's most defiant—perhaps his only certain—presumption regarding the future. Heaven alone knows what will happen a week after Christmas, but come what may, we are calling it 1 January 1961.

Letters to the Editor

A British Atomic Forum

SIR, I have read with great interest the able article on "Britain and the European Atomic Forum" (ENGNG., 28 Oct. '60, p. 571).

British industry has been watching this development closely, but for the reasons set out so clearly in this article it is not prepared to make up its mind too quickly. Whether or not to enter yet one more international body "distracting the too few and overworked experts from their jobs" demands careful thought, for it is evident that this country would be ill-advised to enter a body of the stature of Foratom (Forum Atomique Europeen) unless it was ready to play an active part in it.

The Federation of British Industries has decided, therefore, to invite representatives of the cultural, scientific, economic and industrial interests who would form part of a British Forum to meet for an exchange of views, and it is hoped to arrange such a meeting shortly. The views expressed at it should enable a decision to be taken on British participation.

Yours faithfully,

A. J. H. DOVE,
Technical Director.

Federation of British Industries,
London, SW1.
6 December, 1960.

Longevity of the DAF Car Belt Drive

SIR, With reference to the article entitled "Small Cars Give Stimulus to Research," by Dr. D. J. K. Stuart (ENGNG, 14 Oct. '60, p. 531), apparently the author doubts the long life and the minimum maintenance of the belt drive on the DAF car.

I wish the author had studied some objectively written test reports on the DAF car, which no doubt he could have got hold of, before trying to voice his opinion in such an important journal as ENGINEERING.

Yours very truly,

H. J. SINOT.

c/o Comp. Shell de Venezuela,
Maracaibo, Venezuela.
26 November, 1960.

Events in Advance

Business Efficiency Demonstration in Cardiff

ONE of the largest exhibitions of office apparatus to be held in Wales will take place in the Sophia Gardens Pavilion, Cardiff, from 21 to 24 March, 1961. The Business Efficiency Exhibition, as the display will be known, is being organised by the Office Appliance and Business Equipment Trades Association, 64 Cannon Street, London, EC4 (Tel. CENtral 7771), and will be opened by the Lord Mayor of Cardiff, Alderman Mrs. Dorothy Lewis, O.B.E.

One of the principal objects of the exhibition will be to enable industry throughout Wales and the south-west of England to study the latest developments for speeding up clerical work and the progress which has been made in connection with electronic devices for business purposes. Up to the present time, more than 60 firms, with factories in many parts of Britain, have signified their intention of taking part.

Altogether, the exhibition will cover some 10,000 sq. ft of floor space. The machinery on display will include electronic computers and calculators, microfilming equipment, photocopying apparatus (including apparatus which will make offset-litho printing machinemasters), a new type of cordless telephone switchboard, typewriters, accounting machinery, centralised dictating machinery, office printing and composing machines which possess a choice of some 300 different type faces (any two of these can be used at the same time and they can be changed in a matter of seconds), xerographic printers, steel furniture, fire-resistant equipment, safes and security devices, duplicators and cheque-signing machines.

Among the many other fascinating devices expected to be on display may be mentioned apparatus for counting banknotes at the rate of 50,000 an hour, for cutting duplicator stencils electronically, and for cutting to shreds secret documents, thereby rendering them absolutely unreadable. Cash registers will be on show which not only compute the change for any sum tendered but also deliver the money itself automatically.

Next Year's Engineering and Marine Exhibition

IT IS an inspiring thought that, whereas half a century ago, when the first "Shipping, Shipbuilding, Mercantile Marine and General Engineering Exhibition" was held at Olympia, engineering exports from Britain accounted for but 12 per cent of this country's total overseas earnings from manufactured goods and produce, today it is a very different story.

At present engineering exports account for some 43 per cent of the nation's total exports and the Engineering, Marine, Welding and Nuclear Energy Exhibition—as the show is now styled—has become one of the most outstanding events in the British Engineering calendar. The next exhibition of the series—they take place once every two years—will be held at Olympia, London, W14, from 20 April to 4 May, 1961, and, as previously, it is being organised by F. W. Bridges and Sons, Limited, Grand Buildings, Trafalgar Square, London, WC2 (Telephone: WHItehall 0568).

Well over 500 exhibitors are expected to take part in next year's event, their stands occupying the whole of the 275,000 sq. ft of floor space available in Olympia's three main halls and their galleries. The number of exhibitors—especially of those from abroad—could well be increased, were more space available, for the event has become an internationally recognised institution, not only in Europe but throughout the world, for the display of engineering and cognate manufactures. It is, indeed, a large shop window with a very wide range of products.

Coverage in the mechanical engineering field is particularly comprehensive and includes boilers, furnaces, foundry equipment, generators, petrol and diesel engines, oil and gas engines, gas turbines, evaporators, cranes, pumps, valves, transformers and heavy steelworks plants, to mention but a few products haphazardly.

Ancillary processes and manufactures, such as corrosion prevention, radiography, metal refining, lubrication, testing, measuring, heat insulation, fire prevention, mechanical handling and protective clothing, are also covered. So, also, are ships' davits, radar equipment, searchlights, steering gears, anchors, propellers, cables and many other items of ship fitting and ship construction.

At the last exhibition, in 1959, a diesel engine weighing more than 100 tons was on show. On several occasions, there has been exhibited in the National Hall a 70 ton marine diesel engine running under its own power. To accommodate this exhibit, a pit measuring 40 ft by 8 ft, by 4 ft deep, has to be dug. Among other interesting exhibits of the past which may be mentioned are a replacement propeller for the Queen Elizabeth, the turbine blading for Calder Hall and Chapel Cross nuclear power stations and the first gas turbine ever to be seen at work at a public exhibition.

In 1959, one firm of exhibitors was able to arrange for a television link-up with their works some 80 miles away, thereby enabling many interesting processes being carried out at the works to be watched by visitors to their stand at Olympia. It is safe to prophesy that next year's British exhibitors will uphold their

past traditions and that the 1961 exhibition will have on show numerous examples of outstanding equipment and modern techniques from many parts of the world.

Exhibitions and Conferences

Rubber and Plastics in Cables, Conference.—Wed., 1 Mar., 1961, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Organised jointly by the Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8 (Tel.: BAYswater 9101); and the Plastics Institute, 6 Mandeville Place, London, W1. Tel. WELbeck 5439.

Boat Show, Chesapeake Bay.—Wed., 1 Mar., to Mon., 6 Mar., 1961, at the 5th Regiment Armory, MNG, Baltimore. Organised by Exhibitors Inc., Baltimore Office, 1006 Cathedral Street, Baltimore 1, Maryland, USA.

Domestic Arts Exhibition.—Thurs., 2 Mar., to Sun., 19 Mar., 1961, in Paris. Organised by the Salon des Arts Menagers, Grande Palais (Porte H), 111 Avenue Alexandre, Paris 8e.

Leather Goods Trade Fair, International.—Sat., 4 Mar., to Thurs., 9 Mar., 1961, in Offenbach. Organised by Offenbacher Messe-Gesellschaft m.b.H., 110 Kaiserstrasse, Offenbach-on-Main, Germany.

Lyons International Trade Fair, 43rd.—Sat., 4 Mar., to Sun., 12 Mar., 1961, in Lyons. Agents in the United Kingdom: Robert Brandon and Partners Ltd., 47 Albemarle Street, London, W1. Tel.: HYDe Park 0901.

Frankfurt International Spring Fair.—Sun., 5 Mar., to Thurs., 9 Mar., 1961, at Frankfurt. Inquiries in the United Kingdom should be addressed to Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London, EC4. Tel. CENtral 5050.

Gift Show, Boston.—Sun., 5 Mar., to Thurs., 9 Mar., 1961, at the Hotel Statler and the First Corps Cadet Armory, Boston. Organised by Little Brothers Shows Inc., 220 Fifth Avenue, New York 1, USA.

Leipzig International Spring Fair.—Sun., 5 Mar., to Tues., 14 Mar., 1961, at Leipzig. Applications in the United Kingdom should be sent to Leipzig Fair Agency in Great Britain, 39 St. James's Place, London, SW1. Tel. HYDe Park 3111.

Oil and Colour Chemists' Association: 13th Technical Exhibition.—Mon., 6 Mar., to Thurs., 9 Mar., 1961, at the Royal Horticultural Society's new hall, Greycoat Street, London, SW1. Association's offices: Wax Chandlers' Hall, Gresham Street, London, EC2. Tel. MONarch 1439.

Agricultural Machinery Exhibition, International.—Tues., 7 Mar., to Sun., 12 Mar., 1961. Organised by the Salon International de la Machine Agricole, 95 Rue Saint Lazare, Paris 9e.

"Daily Express" Brighter Homes Exhibition.—Tues., 7 Mar., to Sat., 25 Mar., 1961, at the City Hall, Deansgate, Manchester. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester. Tel. Deansgate 6363.

"Daily Mail" Ideal Home Exhibition, 38th.—Tues., 7 Mar., to Mon., 3 April, 1961, at Olympia, London, W14. Organised by Associated Newspapers Ltd., 161-163 Queen Victoria Street, London, EC4. Tel. FLEet Street, 6000.

Canadian National Sportsmen's Show.—Fri., 10 Mar., to Sat., 18 Mar., 1961, in the Coliseum, Exhibition Grounds, Toronto. Organised by the Toronto Anglers' and Hunters' Association, 85 King Street East, Toronto, Ontario, Canada.

Inventors' Exhibition, Tenth International.—Fri., 10 Mar., to Sun., 19 Mar., 1961, in Brussels. Apply to the Institute of Patentees and Inventors, 207-208 Abbey House, 2-8 Victoria Street, London, SW1. Tel. ABBey 1616.

Toy and Trade Fair, 11th International.—Sun., 12 Mar., to Fri., 17 Mar., 1961, at the Hotel Statler Hilton, New York. Organised by International Trade Shows, 545 Fifth Avenue, New York 17, USA.

Vienna International Spring Trade Fair.—Sun., 12 Mar., to Sun., 19 Mar., 1961, in Vienna. In the United Kingdom, applications should be made to the Austrian Foreign Trade Representative, 1 Hyde Park Gate, London, SW7. Tel. KNIghtsbridge 6938.

Agricultural and Animal Farming Fair, 63rd International..—Sun., 12 Mar., to Mon., 20 Mar., 1961, at Verona. Apply to the Fiera di Verona, Piazza Bra, Verona, Italy.

Utrecht International Spring Trade Fair.—*Consumer goods:* Mon., 13 Mar., to Sat., 18 Mar., 1961, at Utrecht, Holland. *Technical goods:* Mon., 13 Mar., to Wed., 22 Mar., 1961, at Utrecht, Holland. In the United Kingdom, applications should be made to Mr. W. Friedhoff, Netherlands Chamber of Commerce, 10 Gloucester Place, London, W1. Tel. WELbeck 9971.

Motor Show, International.—Thurs., 16 Mar., to Sun., 26 Mar., 1961, in Geneva. Organised by the Fondation du Salon de l'Automobile, 1 Place du Lac, Geneva, Switzerland.

Gift Show, Philadelphia.—Sun., 19 Mar., to Wed., 22 Mar., 1961, at the Hotel Benjamin Franklin, Philadelphia. Organised by Little Brothers Shows Inc., 220 Fifth Avenue, New York 1, USA.

Canadian Restaurant Association's Annual Convention and Exhibition, 17th.—Mon., 20 Mar., to Thurs., 23 Mar., 1961, at the Automotive Building, Exhibition Park, Toronto. Apply to Mr. D. G. Adamson, Director of Conventions, Canadian Restaurant Association, 60 Avenue Road, Toronto 5, Ontario, Canada.

Western Metal Exposition, Twelfth.—Mon., 20 Mar., to Fri., 24 Mar., 1961, in the Pan-Pacific Auditorium, Los Angeles, California. Organised by the American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio, USA.

Business Efficiency Exhibition, Regional.—Tues., 21 Mar., to Fri., 24 Mar., 1961, at Sophia Gardens Hall, Cardiff. Organised by the Office Appliance and Business Equipment Trades Association, 64 Cannon Street, London, EC4. Tel. CENtral 7771.

Electrical Engineers Exhibition, Tenth.—Tues., 21 Mar., to Sat., 25 Mar., 1961, at Earl's Court, London, SW5. Sponsored by the Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1 (LANgham 5927); and organised by Electrical Engineers (ASEE) Exhibition Ltd., 6 Museum House, 23 Museum Street, London, WC1. Tel. MUSeum 3450.

Witwatersrand Agricultural Society's Rand Easter Show.—Tues., 21 Mar., to Mon., 3 April, 1961, at Milner Park, Johannesburg. Details from the secretary, Witwatersrand Agricultural Society, P.O. Box 4344, Johannesburg, South Africa.

World Agricultural Exhibition.—Tues., 21 Mar., to Thurs., 20 April, 1961, in the Exhibition Grounds, Egyptian Agricultural Society, Guezira, Cairo. Apply to the Exhibition Committee, Central Ministry of Agriculture, United Arab Republic, Cairo, Egypt. (Change of dates.)

The Professional Engineer—His Employment and Development, Conference.—Wed., 22 Mar., 1961, in London. Organised by the Engineers' Guild, 78 Buckingham Gate, London, SW1. Tel. ABBey 7315.

Boat Show, National.—Fri., 24 Mar., to Sun., 2 April, 1961, at McCormick Place, Chicago. Organised by the Outboard Boating Club of America, 307 North Michigan Avenue, Chicago 1, Illinois, USA.

"Birmingham Mail" Homes and Gardens Exhibition.—Wed., 29 Mar., to Sat., 22 April, 1961, at Bingley Hall, Birmingham. Architecture, home planning and household goods. Organisers: Herbert Daniel Exhibitions Ltd., 3 Clifford Street, London, W1.

Meetings and Papers

Institute of Marine Engineers

GLASGOW
"Developments in Marine Steam Turbine Design," by Dr. T. W. F. Brown. Scottish Section. Joint meeting with other Institutions. 39 Elmbank Crescent, Glasgow, C2. Tues., 20 Dec., 6.30 p.m.*

Institution of Electrical Engineers

BIRMINGHAM
"Broadening University Courses": Discussion, to be opened by Dr. H. E. M. Barlow. South Midland Centre. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Mon., 2 Jan., 6.30 p.m.*

BRIGG
"Electrical Safety in Factories and on Electricity Supply Systems": Informal Discussion. North Midland Centre. Angel Hotel, Brigg, Lincolnshire. Mon., 19 Dec., 7 p.m.*

Institution of Engineers-in-Charge

LONDON
"Modern Uses of Fuel Oil," by G. E. Fenner. Caxton Hall, off Victoria Street, SW1. Wed., 11 Jan., 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Developments in Marine Steam Turbine Design," by Dr. T. W. F. Brown. Joint meeting with the Greenock Association of Engineers and Shipbuilders and other Institutions. 39 Elmbank Crescent, Glasgow, C2. Tues., 20 Dec., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

BRISTOL
"Mechanical Services in the New Lloyd's Building," by J. R. Kell. South Western Branch. RWA School of Architecture, Bristol. Tues., 3 Jan., 6.30 p.m.

GLASGOW
"Applications of Automatic Controls to Heating and Ventilating Systems," by C. G. Painton. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 20 Dec., 7 p.m.

Institution of Mechanical Engineers

LONDON
"Safety on Construction Sites": Discussion. Steam Group. Mon., 19 Dec., 6 p.m.*
Film Evening. London Graduates' Section. Tues., 20 Dec., 6.30 p.m.*

CHELMSFORD
"The Investigation of Radio Resources at Jodrell Bank," by Dr. H. P. Palmer. Eastern Branch. Joint meeting with the Chelmsford Engineering Society. Hoffman's Social Hall, Chelmsford. Thurs., 5 Jan., 7.30 p.m.

GLASGOW
"The High-Speed Heavy-Duty Diesel Engine: Its Development, Design and Application," by Dr. Ekhart Schmidt. Repetition of a James Clayton Lecture. Scottish Branch. Joint meeting with the Scottish Section of the Institution's Automobile Division. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Mon., 19 Dec., 7.30 p.m.

LEICESTER
"The Vibration of Vertical Milling Machines under Testing and Working Conditions," by Professor H. A. Tobias. East Midlands Branch. College of Technology and Commerce, Leicester. Thurs., 5 Jan., 7.15 p.m.

Institution of Plant Engineers

PETERBOROUGH
"Future Railway Development in Peterborough and District": Discussion. Peterborough Branch. White Lion Hotel, Church Street, Peterborough. Tues., 3 Jan., 7.30 p.m.

ROCHESTER
"Principles of Instrumentation," by D. Mooney. Kent Branch. King's Head Hotel, High Street, Rochester. Wed., 21 Dec., 7 p.m.

Institution of Structural Engineers

BIRMINGHAM
"Precast Concrete Frame Construction," by Bryan E. Griffin. Midland Graduates' and Students' Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Fri., 6 Jan., 6.30 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., 30 Dec., 7 p.m.*

BIRMINGHAM
"Engineering in Chemical Works," by E. R. Brazier. Midland Section. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Wed., 4 Jan., 7 p.m.

Leeds Metallurgical Society

BRADFORD
"Some Recent Developments in the Welding of Metals," by E. N. Gregory. Bradford Institute of Technology, Bradford. Wed., 4 Jan., 6.30 p.m.

Newcomen Society

LONDON
"Joshua Gilpin: An American Manufacturer in England and Wales: Part II, 1811-1814," by Dr. Harold B. Hancock and Dr. Norman B. Wilkinson. Wed., 4 Jan., 5.30 p.m.

Reinforced Concrete Association

BIRMINGHAM
"Reinforced Concrete Construction in the Coal Industry," by C. A. C. Davies. Midland Counties Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 3 Jan., 6 p.m.*

Royal Aeronautical Society

LONDON
"Aircraft Shapes and Their Aerodynamics for Flight at Supersonic Speeds," by Dr. D. Küchemann. Tues., 20 Dec., 7 p.m.
"British Universities and Aeronautical Research," by Professor A. D. Young. Fourth Lanchester Memorial Lecture. Thurs., 22 Dec., 6 p.m.*

Royal Society of Arts

LONDON
"The Legend of the Phoenix," by Dr. Maurice Burton. Juvenile Lecture. Fri., 30 Dec., 2.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Film Evening. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 20 Dec., 7 p.m.

Society of Instrument Technology

SHEFFIELD
"Instruments and Cherry Blossom—Some Impressions of a Technical Visit to Japan," by W. C. Heselwood. South Yorkshire Section. The University, St. George's Square, Sheffield 1. Wed., 4 Jan., 7 p.m.

Women's Engineering Society

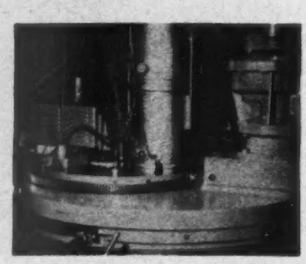
LONDON
"Ground Effect Machines": Discussion. Hope House, 45 Great Peter Street, SW1. Wed., 11 Jan., 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

ROTARY TABLE

High Vacuum Work



DESIGNED to work while sealing against a high vacuum is a rotary table for mounting on a Zeiss electron beam welding machine.

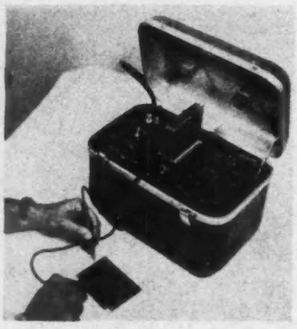
The machine produces high quality flux free welds in a vacuum of 10^{-4} Torr. The table consists basically of two superimposed Roballo wire race ball bearings slewing rings, the important feature being the vacuum tightness rather than the accuracy of rotation. The slewing ring is not used as a bearing in the usual sense but as a base or stopping ring with a moving mechanism by which the beam and focusing unit, placed upon it, can be rotated for circumferential welding on a large diameter, or transported in a straight line by a planetary motion when straight welds are required.

The guides and sleeves must maintain the required vacuum in the container below and the seal is provided by two rows of cap sleeves made by Carl Freudenberg, using an intermediate vacuum of 10^{-2} Torr. All threaded holes are blind so that the maintenance of the vacuum is not affected by any leakage from straight through holes. The wires are secured in their grooves, since the bearing has to be dismantled frequently to gain access to the vacuum chamber.

The two wire ball bearing slewing rings are arranged eccentrically to each other. The loadings are 2 tons axial load on the ball track diameter of 600 mm and 7·1 tons axial on the ball track diameter of 920 mm. The rotating sections of the beam welding machine are shown in the illustration. *Roballo Engineering Company Limited, 42 Dover Street, London, W1.*

DIODE TESTER

Automatic Operation



SELF-CONTAINED and completely portable, a tester for diodes is automatic in operation.

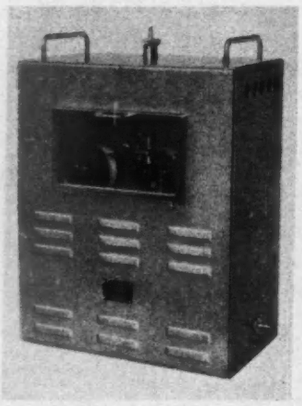
The unit measures 11½ in by 10 in by 10 in and weighs 12 lb. It is designed primarily for testing diode matrix boards used in conjunction with 16 or 28-switch electrical timers. It consists of regulated power supplies, comparison bridge, detector, and the necessary switching mounted behind the front control panel. The operating controls, indicators and diode matrix board receptacle are mounted on the front.

Tests made include checking the presence and polarity of diodes in specified circuit positions on the matrix boards. In addition the forward current is tested at 1 V and reverse leakage at 25 V. If correct, a green light shows on the front panel; those diodes failing the tests or not fitted on the board are indicated by a red light.

Operation is from any standard 115 V a.c. 60 cycle supply. The case is made of glass fibre and the operating temperature range is from 40° F to 150° F. The matrix board receptacles are keyed to ensure correct insertion, and visual comparison of the notches further simplifies location. Calibration of the unit can be carried out by a technician without engineer supervision and it is claimed that the instrument has also been successfully used as an insulation tester by a simple adjustment of the function switch. *A. W. Haydon Company, Culver City, California, USA.*

AIR POLLUTION RECORDER

Automatic



THE LEVEL of air pollution can be automatically recorded by a new monitor, without reference to a comparator.

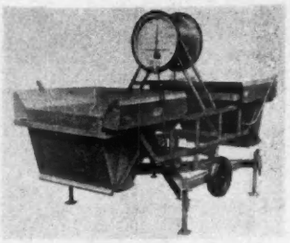
Basically the instrument consists of a filter paper with the associated drive mechanism and a diaphragm vacuum pump. The drive mechanism reels the filter paper, pulling it through two lightly clamped plates at a constant rate of feed. Two ¼ in diameter ports bored concentrically in the clamping plates allow the pump to draw air through the paper.

The resulting pressure differential across the paper is measured and recorded. The pressure drop between the filter paper and the pump is dependent on the clogging of the paper and therefore on the rate of deposition. A pressure sensitive switch can be used to control an external circuit if the deposit reaches a chosen figure.

Samples may be taken at 24, 8 or 1 hour intervals with a break of approximately 30 seconds between. An average of 5·45 cu. ft of air passes per hour with a pressure drop of 20 in Hg using clean paper, changing to 15 in Hg when completely clogged. Paper feed rate is 76 mm per hour and the reel holds 100 metres. Special units are available for automatic read out and very dirty conditions. *Fleming Radio (Developments) Limited, Caxton Way, Stevenage, Herts.*

BATCHER

Twin Bucket Design



A REDESIGNED version of the Forward twin bucket weigh batcher has the frame constructed entirely of rectangular tubing.

The advantage of this form of construction is that of great strength coupled with lightness; the smooth form also prevents any aggregate material from lodging on the frame and fouling it. All corners are smoothly radiused. Another addition to the earlier models is the taring ring which has four adjustable pointers that can be preset to indicate required weights. The dials themselves are carried on a bridge section which can be easily removed and packed into one of the skips for storage or shipment.

The model illustrated has two skips of 14 cu. ft capacity with bottom discharge. A separate dial is provided for each. The frame which supports the mechanism and skips is mounted on a turntable and can be rotated through 360° so that one skip can be discharged while the other is being loaded. An undercarriage has two 16 in by 4 in wheels for transport and four adjustable stabilising jacks which can be extended to steady the machine during operation.

Graduations on the standard dials are up to 1,400 lb in 5 lb divisions; the pointer on each is adjustable to zero. The dials are interchangeable and do not have to be specially calibrated for each machine so that replacement is easy. The weighing mechanism is the compound lever type which supports each skip on four sets of hardened steel knife edges and bearings of special design. Overall dimensions are 10 ft by 5 ft by 5 ft 9 in high and the net weight is 13 cwt. *Thos. W. Ward, Limited, Albion Works, Sheffield.*

CLIP SEALER

Using Reeled Wire

ORDINARY reeled mild steel wire is used to form the clips in a new sealing machine.

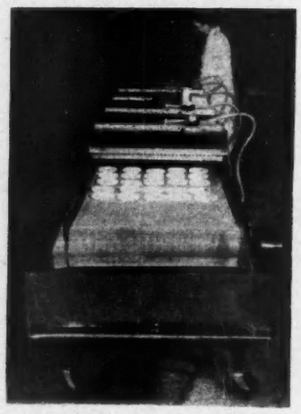
The illustration shows the machine installed to seal Netlon packages of fruit. The Netlon is stored over a tube down which the fruit is fed. When the required number has been received, the operator necks the Netlon tube and inserts it in the jaws of the sealer. This initiates the automatic cycle.

Wire from two reels is fed to the two independent clip forming units. In each a slide advances and cuts the wire to length, then forms it into a U-shape round a mandrel. The mandrel withdraws and the slide pushes the clip over the necked-down Netlon. A second slide, carrying a clinching tool, closes the clip, while a blade severs the material between the two clips, leaving one of them to seal the top of the severed pack and the other the bottom of the next.

It is claimed that using reeled wire reduces the cost of sealing by as much as 80 per cent. A 4 lb reel will make about 9,000 clips for a cost of 7*s*. Speed of operation is about 100 double clips per minute, equivalent to 100 packages. The machine is pedestal mounted and can be swivelled into the horizontal or vertical positions. It is driven by a 220/240V motor consuming 750 W. The action of inserting the neck between the jaws engages a single revolution clutch driving the cam shaft that controls the slides and wire feed. *Spicers Limited, 19 New Bridge Street, London, EC4.*

DRYER

Infra-Red Lamps



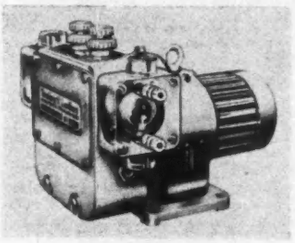
NOW available is a standard unit infra-red dryer, the L/X5, with versions suitable for both flat and shaped objects.

The heat is supplied by five projector units each containing three elements constructed of unbreakable Inconel tubing of a patented oval shape with very long life. The articles to be dried are carried under these projectors by a 13 ft conveyor feeding into a collecting hopper. Shorter conveyors are available and there are alternative widths of 18 in, 24 in, 36 in, 42 in, and 48 in. The 24 in model is illustrated.

The speed of the conveyor is variable and can be adjusted to give drying times from 15 seconds to 4 minutes. The two narrower units are fitted with 10 kW projectors; in the other widths units of 15 kW and 21 kW are fitted as standard. Some items do not need the full rating and lower powered units can then be fitted. The machines are mounted on castors to make them movable for convenient positioning. The range of drying temperatures that can be obtained varies from 60° C (140° F) to as high as 400° C. Suitable operations for the dryer are for gums, latex, varnish, silkscreen inks, textiles, and vitreous enamel frits. *George Vokes (Infra Red) Limited, Infra Red Works, High Road, New Southgate, London, N11.*

PRESSURE FEEDER

For Liquids



THE Tolu feeder now available in this country is designed for injecting doses of liquids under pressure.

The unit works on the diaphragm principle, power being supplied by a ¼ h.p. motor driving through a train of reduction gears. Models are available with either one or two diaphragms, the capacity of each being variable from ½ to 7 gallons per hour. The working pressure can be up to a maximum of 70 lb per sq. in.

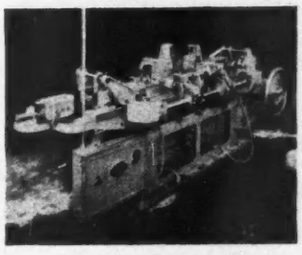
The two diaphragms are timed to work alternately so that the loading on the motor is kept uniform. Otherwise their functioning is independant. This arrangement allows two liquids to be handled by the one feeder unit or, alternatively, one diaphragm can be in regular use and the other held as a reserve or standby.

Control of the dose is by the knurled knobs on the top of the pump housing. These are scaled from 0 to 10 and the dose rate (apart from the initial position) varies linearly with the setting number. Adjustments to the rate can be made with the pump running so that the correct working proportions can be found.

The diaphragms and check valves work in transparent plastic housings and so can be observed in operation. Diaphragms, housings and all other parts likely to come into contact with the solution being handled, are made of materials with high chemical resistance. The valves are screwed into the pump housing and can easily be removed for inspection without the use of tools. No lubrication is required apart from the reduction gear case which is filled with oil. *Neldco Processes Limited, Crossway House, Bracknell, Berkshire.*

MULTI-SLIDE MACHINE

Double Feed



LATEST addition to the U.S. range of forming machines is the model 36D illustrated.

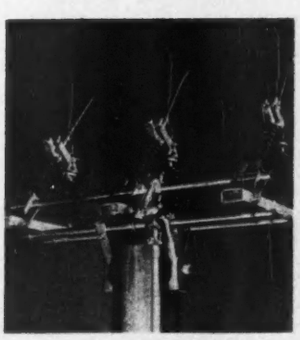
This machine has been developed from the model 35 and is, in effect, a double-ended machine. Strip material is fed in at both ends, an arrangement that is well suited to the manufacture of assemblies that could include two formed stampings made and assembled in the machine, or two stampings made in the machine and assembled with a prefabricated hopper fed member. Alternatively the machine can be used for the production of two separate stampings not requiring assembly, or one component in the manner of a normal multislide.

The 36D will handle stock up to 3 in wide by approximately $\frac{1}{16}$ in thick. The feed length of each end is separately adjustable up to a maximum of 6 in. Machines are supplied with a stock straightener, slide feed mechanism and stock check at each end; a 25 ton die head in each of the two sections; one four-slide forming position and a common stripper unit with double motion. The machine is powered by a 7½ h.p. motor driving through a variable speed unit and an air operated clutch. Lubrication is automatic.

In addition to the standard equipment each section of the machine can be equipped with an extra die head, a cutoff slide and a rear auxiliary slide. Since the machine is the conventional U.S. symmetrical design, the die heads can be actuated by either the front or rear drive shaft. It is claimed that the basic design and the auxiliary units can make up a very versatile tool. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

LINE ISOLATOR

Torque Drive



SIMPLICITY and low cost are two claims for a new range of 11 kV line isolators fitted with a torque drive.

The isolators are available in two and three insulator types of 400 A normal current rating. The design has been tested at 13·1 kA for 3 seconds at 11 kV. There is a choice of four different insulators and these and the contact and arc horn parts are easily replaceable. The fixed contact has U-shaped jaws to give increased pressure with increased current. The moving contact is cylindrical and can be rotated to present a new contact surface when the first is worn.

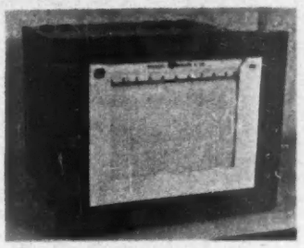
At the base of the pole, a swinging handle turns the torque tube and locks over lugs in either the closed or the open position. At the top of the drive tube is a pin set at an angle which rests in a mating slot. The slot housing is part of a flat plate fixed to the rocking arm by piercing screws so that, when the tube is rotated, the contacts are thrown clear.

The supporting steelwork accepts either the two or the three insulator type for vertical or horizontal mounting on single or H-post structures. Extensive use of standard pipe reduces the cost, and piercing screws remove the need for ordering pipe in exact lengths. *Switchgear and Equipment Limited, Banbury, Oxfordshire.*

The rated capacity of the Venner time switch described on page 576 (28 October) should have been given as 30A.

RECORDING POTENTIOMETER

No Slide Wire



IN a new recording potentiometer the conventional slide wire has been replaced by a force balance unit that is not subject to wear.

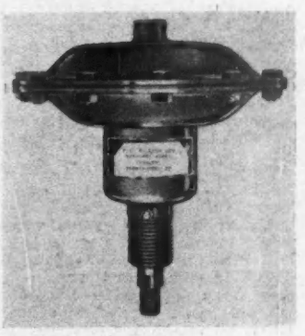
Wear occurs particularly when the contact oscillates over a small length. The force balance unit obviates this and also eliminates the step from one turn of wire to the next.

The instrument is designed to measure and record small direct-current outputs such as are obtained from thermocouples, resistance strain gauges, and other transducers. The minimum input range is 0 to 1 mV. There can be up to twelve input channels, each channel being cyclically switched at 5 second intervals and a recording made on a 10½ in wide strip chart with a choice of speed rates. Reference information is derived from a highly stabilised voltage source, the unbalance signal being a function of the input voltage and the error signal produced by the force balance unit.

The force balance unit consists of a coil suspended in a magnetic field working against a hair spring which, in turn, is linked to the pen arm by a driving drum. The coil carries a vane which controls the light reaching a photocell. An error signal to the servo motor produces a movement of the vane resulting in a change of resistance in the photocell, and a change of current in the coil which tends to restore it to the balance position. Rotation of the drum is 240° for a 1° movement of the coil, affording a 240 : 1 stabilising effect against temperature changes and voltage fluctuations. *Smiths Industrial Division, Kelvin House, Wembley Park Drive, Wembley, Middlesex.*

PNEUMATIC THRUSTER

2½ Tons Force



A RANGE of pneumatic thrusters for general work is now available in this country.

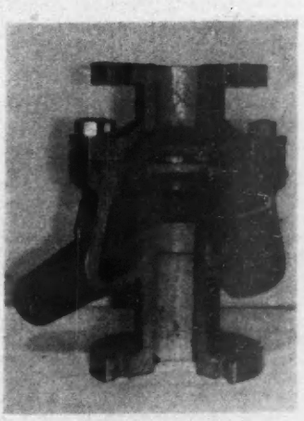
There are two series: one with a comparatively short stroke using a diaphragm as illustrated, and the other with a longer stroke using a piston. Both are designed to work on an 80 lb per sq. in air line.

The diaphragm model, type M, is made in four sizes with thrusts of 660, 1,236, 2,640 and 5,500 lb. The strokes range from 1·2 in to approximately 2 in. The bodies are made of steel sheet and the diaphragm is of oil resistant plastic. The thrusters are single acting and the return is by a coil spring. A lubricating nipple is fitted on the thrust rod sleeve for regular oiling. The rod sleeve is threaded externally (either ¼ in or ½ in gas) for use as a fixing and the end of the thrust rod is also threaded.

The piston version, type K, is made in two sizes, with thrusts of 350 and 660 lb. The strokes are 2½ in and 2½ in approximately respectively. The weights are 2·4 and 4 lb. The cases are made of steel sheet, inside which is the spring-returned piston. Sealing between the case and piston is by a long-lasting synthetic rubber ring. As in the diaphragm model, the sleeve is threaded for fixing and is provided with a lubricating nipple for the piston rod. A range of hose connecting nipples is available for use with the thrusters. *P. L. Wilcox Limited, Standard Works, Tyseley, Birmingham 27.*

PIPELINE SEPARATORS

Vortex Action



THE range of Supreme vortex separators is designed for the removal of steam and oil droplets from compressed air or other gases.

The vortex is generated by allowing the gas to impinge on a vane plate. There are no moving parts and therefore no maintenance. The angle and form of the blades is designed for each application. Models are available for use in the horizontal or vertical positions and with a slight modification can be used in upward flowing lines making them suitable for exhaust heads.

Models are available for a large range of pressures. Pressures up to 150 lb per sq. in can be handled by separators made in cast iron. Up to 500 lb per sq. in, cast steel types are employed, and cast alloy steel will withstand up to 1,500 lb per sq. in. Above that figure special steels must be used. Other materials can be supplied for use in corrosive conditions according to the customer's specification.

It is claimed that with the Supreme separators there is no reversal of flow and that as a result the pressure drop across the separator can be maintained below 1 per cent. The efficiency of the standard model is rated at 99 per cent, but higher figures have been recorded. *J. H. Carruthers and Company Limited, East Kilbride, Glasgow.*

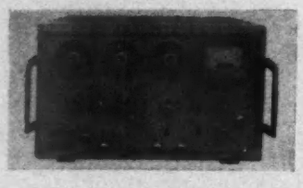
PULSE GENERATOR

Rectangular Form

A NEW decade pulse generator, model GO1005, will operate over the repetition frequency range from 10 c/s to 1 Mc/s.

Typical applications for the instrument are for the accurate determination of transmission characteristics and transient response of amplifiers and networks, or for testing the frequency and amplitude limits of electronic counters. It will provide positive or negative-going single or double rectangular pulses of up to 100V amplitude at repetition rates in the full frequency range stated above.

There are three sets of decade controls with illuminated dials that permit coarse and fine adjustments of pulse duration, repetition rates and signal delay. It is claimed that the built-in amplitude monitoring meter allows output requirements to be set up with both ease and accuracy. The signal delay time, relative to a 10V prepulse output, is variable over the same range as the rectangular pulse duration, that is, from 250 mμ sec to 100 m sec.



When the instrument is being used in the double pulse mode of operation, the leading edge of the first rectangular pulse coincides with the prepulse, and the leading edge of the second identical rectangular pulse occurs after the set signal delay. In addition, a delayed prepulse is available approximately 250 mμ sec after the prepulse, thus providing a trigger output which may be made to coincide exactly with the leading edge of the main rectangular pulse.

The makers claim that the extensive delay facilities incorporated in the instrument and its internal or external triggering modes (these may range up to 2 Mc/s) make the GO1005 a very versatile instrument suitable for most laboratory and testing applications. *Solartron Instruments Limited, Cox Lane, Chessington, Surrey.*

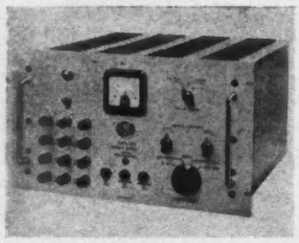
POWER PACK

Range of Outputs

A NEW stabilised power supply unit offers a range of voltages for use in laboratories.

Alternative inputs are 110-120 V or 190-250 V single phase 40-60 cycles. Positive d.c. voltage outputs, all stabilised, cover from zero to 500 V in four ranges, which overlap by about 10 V. A stabilised negative d.c. voltage of −250 V is included and a potentiometer across this provides a variable stabilised output. Any of the positive ranges will provide a d.c. current of 250 mA maximum, and a maximum of 30 mA can be drawn from the negative range. In addition there are two unstabilised a.c. outputs of 6·3 V at 5 A nominal which are centre tapered and independent. They can be connected in parallel or series if required. The d.c. outputs are floating and any point can be connected to earth.

For a supply variation of ± 10 per cent, the stabilised positive outputs do not vary by more than ± 0·1 per cent and the negative supply by not more



than ± 0·5 per cent. The output resistance is less than 0·75 ohm on the positive and 1 ohm on the fixed negative supply. Ripple is less than 3 mV and 1·5 mV respectively. The meter gives readings of volts or milliamperes on a common scale with a range switch.

No electrolytic capacitors are included in the circuit, the functions of smoothing being carried out by high quality paper components. This allows the instrument to operate at relatively high temperatures. The case is well ventilated and measures 19 in by 10½ in by 17½ in. The complete unit weighs 87½ lb. *W. G. Pye and Company Limited, Granta Works, Cambridge.*

POWER DRILL

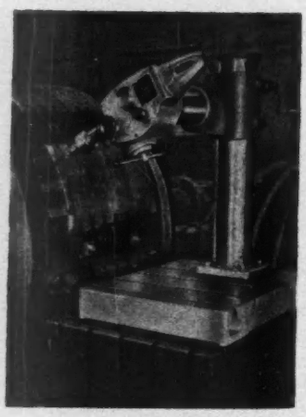
Transportable

NOW available in this country is the Oerlikon UB2 drilling and boring unit.

Mounted on its column, the drilling unit can be moved to any machine in the shop for reaching awkward spots. The head can be swivelled through 360° enabling it to drill vertically upwards if required. It can also be rotated round the vertical column, and is adjustable for height.

Eight spindle speeds are provided covering from 30 to 3,070 r.p.m. and three spindle feeds of 0·0025, 0·005 and 0·01 in per rev. They are selected by a draw knob on the front of the head. The spindle has a down feed of 6 in and the column allows 24 in of vertical movement of the head. The out-reach is also 24 in maximum.

Power is supplied by a two-speed 1·2/1·5 h.p. motor mounted in the cross slide giving the unit a drilling capacity on cast iron of 1 in diameter and precision boring up to 2·5 in. Speeds are selected by two handles on the front,



and there is a sensitive hand down feed. A depth scale can be fitted at the side of the spindle. The tool can also be supplied with a precision compound table for use as a fixed unit in the tool room. *Dowding and Doll Limited, 346 Kensington High Street, London, W14.*

BLOW MOULDER

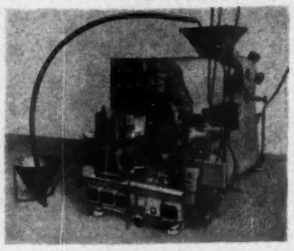
For Large Containers

THE latest addition to the Blowmaster range of machines is one designed for the automatic production of large containers in plastic.

The Type 10 will make containers of 3 gallons capacity from 18 oz of polyethylene at a rate of 50 per hour. Smaller sizes of 40 oz capacity and 4 oz content can be produced at rates up to 250 per hour. The maximum dimensions are 9 in diameter by 20 in high.

A feature of the extruder is that all belts and gear drives have been eliminated by using a hydrostatic transmission. This transmission is made by Chamberlain Industries and consists of a power pack with a variable delivery pump driven by a 20 h.p. motor and a five-cylinder radial hydraulic motor coupled to the extruder screw by an Oldham coupling. The speed is infinitely variable from zero up to 100 r.p.m. and the action can be stopped within half a revolution.

In operation, a plastics tube is first extruded centrally between two fixed mould halves, the length being determined photoelectrically. A platen carrying the mates of the half moulds moves to and fro covering each in turn. As it closes each, a knife cuts off the trapped length and air is forced in to form the hollow body. The photocell also initiates each cycle of operation.



The machine is so arranged that it can be operated with either one or two moulds which need not be of the same shape providing that they have the same material content. Initial closing is by an air cylinder and final pressure is applied hydraulically through two hooks. *Amigo Machine Company Limited, Skylon House, Park Royal Road, London, NW10.*

BORING MILL

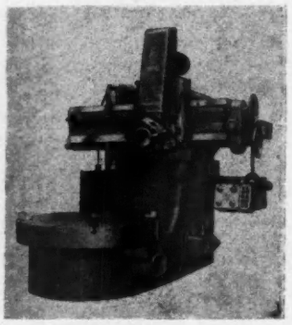
Elevating Cross Slides

AN ELEVATING head model has now been added to the range of Webster and Bennett vertical boring mills.

Three sizes are being made in the EH range with chuck diameters of 3 ft, 4 ft and 6 ft. They can respectively swing 46 in, 58 in and 84 in. The smallest admits 40 in under the cross slide and the two larger ones 48 in. The largest has a vertical cross slide adjustment of 24 in and the turret of 38 in with a maximum clearance of 59 in. The horizontal feed of the turret from chuck centre outwards is 51½ in.

The elevating cross slide is controlled by a separate motor and protected by limit switches. The turret is a steel forging with quick acting positive index and lock. The turret slide may be swivelled to either side and gearing is provided for adjustment. A power rotated turret can also be fitted. The spindle is hollow-centred to facilitate the use of boring bars.

A choice of 12 feeds and speeds is available, selected by direct reading dials



through a hydraulic change system. There is a choice of four speed ranges on the 36 in machine and five on the other two. On the largest, normal speeds are from 3·8 to 83 r.p.m. and high speeds from 4·5 to 100 r.p.m. Special high speed is from 6·5 to 143 and low from 2·5 to 55·5 r.p.m. A special heavy duty drive gives a range from 1·9 to 41·5 r.p.m. All controls are grouped on one panel. *Wickman Limited Banner Lane, Coventry.*

IMPULSE SWITCH

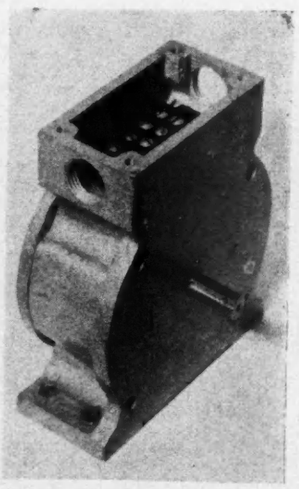
High Speed Operation

HIGH speed electrical switching from a shaft drive is provided by a new unit.

The switch is driven by a ¼ in diameter shaft supported in a sealed bearing at each end of the assembly. Two sets of heavy duty leaf spring contacts are included and the operation is determined by the form of the cam. The two contact sets are at approximately 180° separation and are rated for 1A at 110V on non-inductive loading, or 2·5A at 24V on inductive loads.

The maximum shaft speed for the above ratings is 1,500 r.p.m. but can be increased to 2,500 r.p.m. for 24V 0·2A conditions (for a single counter). The contact gap is 0·01 in and the average resistance 0·05 ohms.

In the E1 version the contacts are operated in progression once per revolution with a few degrees dead angle between them. In the E2 version each pair is closed for approximately 90°, the two pairs being spaced at 180°; they may be operated in parallel. Overall



dimensions of the splashproof case are 4 $\frac{1}{16}$ in wide by 1¾ in deep by 5 in high. *Lancashire Dynamo Electronic Products Limited, Rugeley, Staffordshire.*

Human Element

Overdue Improvement in Engineers' Salaries

AN AVERAGE increase of 32 per cent in the incomes of professional engineers over the last four years?

It looks from the findings of the survey of the Engineers' Guild, in which more than 2,700 completed questionnaires were received from a cross-section of corporate members of the Institutions of Civil, Mechanical, Electrical and Chemical Engineers, as if something very like this is the case.

All too rightly the Guild is able to say that the results of the survey of engineers' incomes in 1955-56 published in connection with the Report of the Royal Commission on Doctors' and Dentists' Remuneration—" showed the incomes of engineers to be so low as to bear little or no relation to the training and experience required of the professional engineer, or to the responsibilities which he carried". The relative position of engineers in relation to other professions was shown to be equally unsatisfactory.

Forward or Back

What cannot be shown by the Guild's new survey is whether the engineer, with a 32 per cent increase in the median income, is correcting the position or slipping back. Over the same period the official index of retail prices shows only a 9·3 per cent rise, so the general rise is some four and a half times the (official) prices increase. The index of weekly wage rates in the United Kingdom shows an increase over the four years of 16·7 per cent, so that on average the engineers would appear to be reversing the post-1940 trend for the gap between the salaried employee and the hourly paid staff to close up.

But the position is much less clearly improving in relation to other professions. The teachers, whether in school or university, have gone rapidly ahead during the last four years. Certainly the engineers have a very long way to go if they are to catch up with the medical profession but, for the moment, they appear to be falling behind rather than moving up.

At the time of the Royal Commission Report, the average of accumulated earnings over the years from 30 to 65, which were taken as the most valuable for the purposes of examination, varied from £54,000 for architects and £59,000 for engineers up to £117,000 for medical consultants.

The figure for National Health Service doctors was £84,000. At that stage in the statistical comparisons the gap between engineers and NHS doctors was £25,000.

But the Royal Commission were not making their inquiry in a vacuum. The recommendations put forward led to an increase from January of this year which took the comparable figure for doctors in the Health Service up to £102,000. The Guild calculates the equivalent figure for engineers in 1959-60 to be £71,000—a gap on this occasion of £31,000, or almost a 25 per cent worsening of the relative position.

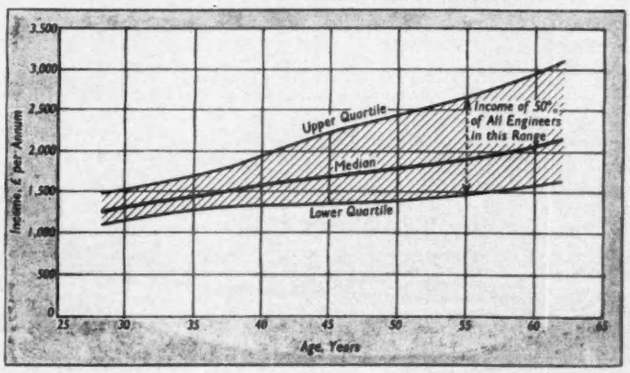
Upsidedown

When a nation in better health than it has ever been before is in the acute difficulties that is Britain in selling its products overseas, it is a curiously upsidedown position that the doctors should be going ahead faster than the engineers.

Some of the sharpest percentage increases revealed by the Guild's work show that the position among young engineers may be changing relatively swiftly. In the 1955-56 survey it was found that 57·3 per cent of those in the 35-39 age group earned less than £1,200 a year and in the same age bracket there were only 5·5 per cent earning more than £2,000. Now, in 1959-60, the below £1,200 group in the same age sector has declined to 13 per cent and the above £2,000 has increased to 14·9 per cent.

Changes like this, and the rising proportion of graduate entrants to the profession, support the belief that a time of rapid change is overtaking the salary situation of professional engineers.

Income distribution 1959-60 of all engineers by ages.



FBI Proposals on Rating and Valuation Bill

Important modifications to the Rating and Valuation Bill have been suggested by the Federation of British Industries.

The FBI is strongly opposed to the main principle of the Bill on the grounds that it will cause hardship in many industries, particularly those with heavy fixed plant and machinery. In these cases it sees the effects of the Bill as retarding the investment upon which economic progress depends.

On the evident appearance that the Government intends to press on with the Bill, the FBI has been studying the possibilities of improving the way in which it operates.

Objection is raised to the provision in the Bill that while the same basis is to be used for all valuation, except in agriculture, the Minister of Housing is to be able to give relief to householders where it is considered that undue hardship will arise.

If special relief against hardship is justifiable for householders, it is equally justifiable for industrial firms, contends the FBI.

And if the extent and duration of the relief are not firmly limited it will tend to persist long after it should come to an end. The transition to full rating when the relief is terminated will still be painful.

The FBI has accordingly suggested that relief to householders should reduce in five equal stages from 1963, ending in 1968, and that the present 50 per cent derating of industry should be similarly tapered down between 1963 and 1968.

Pointing out that these proposals would make the Bill's operation smoother and more equitable, the FBI observes that the Minister adopted the principal of tapering over the rerating of scientific societies.

More at Work and More on Short Time

26,000 more people were at work during October, than in the previous month bringing the total to 23,825,000. Current Ministry of Labour figures show that the largest movements during the month were in distribution, where there were another 25,000 people employed, and in engineering and the manufacture of electrical goods, which increased their labour force by 9,000.

Agriculture lost 10,000, the motor manufacturers ended the month with 6,700 less and in catering and hotels there was a drop of 3,300 in employment.

Two out of three reported by the Ministry of Labour as working short time were in motor plants. The total on short time at the end of October was 95,200, which was 54,700 more than at the end of September. The motor vehicle industry's total of those on short time was 63,500 and other car factories have been affected by the situation since the beginning of November.

With the end of October there were 8,971,000 men and women employed in the United Kingdom's manufacturing industries—300,000 more than twelve months ago and 19,000 above the figure for the end of September.

Among the smaller labour movements (shipbuilding and marine engineering down 2,000, chemicals and allied industries up 2,000, metal manufacture up by the same number) the textile trades added another 4,000 workpeople to their payrolls during October, bringing their total to 871,000 which was slightly above the 865,000 of last August.

80,000 Acres to Join Green Belt

Approval with modifications has been given by the Minister of Housing, Mr. Henry Brooke, to the proposals of the Buckinghamshire County Council to add 88,000 acres to the green belt in the county.

As the pressure on land within and around London grows so the area about the capital affected by urban expansion increases. With this in mind it is significant that in adding some land and removing other from the council's plan, Mr. Brooke has left room for development round certain Buckinghamshire towns. These include Amersham, Beaconsfield, Chesham, Marlow and High Wycombe.

For the towns which will be surrounded by the new green belt acres a growth estimated at some 40,000 to 50,000 people is still possible. In Buckinghamshire 49,000 acres east of a line from Maidenhead Bridge to Amersham is already part of the Metropolitan green belt. Mr. Brooke's modifications are are being made available for public inspection and objections (a number have been met by the Minister) will be considered before the final decision is taken.

New Chairman of Works Managers

Mr. Alan M. H. Davies, at one time an industrial investigator for the National Institute of Industrial Psychology and a former assistant commercial manager at Imperial Chemical Industries' Billingham Works, has been elected chairman of the Institution of Works Managers.

Mr. Hudson Davies, who is 59, is a member of the Grand Council of the Federation of British Industries. He was awarded a Fellowship of the Institution in 1945 for outstanding contributions to industry.

After his spell with ICI, Mr. Davies joined the Hereford firm of H. P. Bulmer in 1933, becoming works director in 1936. Appointed managing director of Fibreglass in 1946, he joined the board of the parent company, the Pilkington Group, in 1952.

Lord Piercy, chairman of the Industrial and Commercial Finance Corporation, has been re-elected president of the Institution for the eighth successive year.

Welsh Railway into New Road Project

Taking advantage of an abandoned section of railway line, between Dowlais Top and Beaufort on the Welsh border, the Minister of Transport has made Statutory Orders changing the line of the Heads of the Valleys Road, which is being modernised to serve in linking the Midlands and South Wales.

The Heads of the Valleys route—road A 465—runs from Hirwaun to Abergavenny. Before it was known that the Merthyr to Abergavenny railway line would be abandoned Statutory Orders were made between 1950 and 1952 establishing routes for completely new sections of road.

The use of the Dowlais Top to Beaufort disused section for the new trunk road will mean that curves and gradients will be considerably smoothed out. Interference with private property will also be less.

Changing the line of the road does not involve any delay in carrying out the scheme. By the new arrangements the by-pass of Brynmawr will lead directly into the new road and there will be links connecting the Ebbw Vale, Tredegar and Rhymney valleys.

A Channel Tube is a Better Prospect

Construction of the Channel Tunnel involves risk of striking water-bearing faults until completion. A tube on the sea-bed avoids this risk and is easier to ventilate, making road traffic feasible.

By D. P. Bertlin, M.Eng., M.I.C.E. Consulting Engineer

THE idea of a Channel tunnel or bridge has been a civil engineer's dream and a general's nightmare for over a hundred years. Various studies have been made of the many difficult problems involved but only recently has a coordinated team effort been attempted, backed by geological field studies, to assess such a venture as a serious commercial proposition. The Channel Tunnel Study Group published a report based on these studies on 28 March, 1960.

According to this Report the only solution which has any chance of being viable commercially is an electric railway tunnel or tube. This may be true as it would save the heavy cost of ventilation, though it must be remembered that one would sacrifice some of the advantages to motorists, such as the ease of driving through at any time, independent of timetables. A tunnel suffers under the disadvantage of having fixed ends, whereas sea and air travel is far more flexible, so it is important to make it as attractive as possible in other repsects.

TUNNEL RISKS

The difficulties of driving a tunnel are slurred over in the Report. The geologists admit that more detailed prospecting is necessary and though they say that "the geological risk" of working in the lower chalk is slight they do not say there is no risk at all. The engineers then take up the point and state that "in order to ensure that the tunnels follow favourable ground and for the safety of the works a service tunnel will be bored at a suitable distance ahead of the main tunnel enabling the ground ahead to be tested by borings." It is far from clear how such a pilot tunnel would help in finding favourable ground though it could help to ensure the safety of the works if suitable precautions were taken. Such precautions might however hamper progress to such an extent as to jeopardise the feasibility of the scheme. The method of dealing with possible fissures is then dismissed in two lines. Bearing in mind the great hydrostatic pressure at the depth of the lower chalk, this would seem to call for a more detailed explanation. The statement in the next paragraph that an immersed tube would have an appreciable advantage in that it would eliminate the geological risk is very true.

In considering the relative merits of tunnel and tube the first question to answer is: can a tunnel be constructed in the time and for the money mentioned in the Report? It is not likely to be unless it is bored through non-water-bearing strata without water-bearing fissures or faults. The cost and time involved in coping with a single inrush would upset all the calculations of months and £ millions—apart from the grave risk of a very serious loss of life. One has only to remember the length of the tunnel and the depth and water pressures involved to realise the catastrophe one would be fighting.

So it would seem imperative to make quite certain that no such troubles would be experienced. But with existing methods of ground exploration it is not possible to be sure that no fissures or faults will be encountered. As one cannot be quite certain, surely a solution which does not have to run the risks of non-homogeneous strata has great advantages. Such a solution is to hand in the precast tube floated out and sunk in a predetermined position. The difficulties of such a form of construction are many and a good deal of experiment necessary before definitive designs could be made; but none of the problems involved approach the difficulty of dealing with a water bearing fissure if met with in driving a tunnel.

To return to the Report and the contention that the tunnel is a commercial proposition. If it is intended to build a tunnel as a financial venture, what justification is there for asking governments to underwrite such a project? Obviously the estimates are very rough (one would like to see the tentative designs on which the estimates are based) and the cost of construction of works of a magnitude and uniqueness of a Channel Tunnel is often substantially underestimated. The governments concerned would benefit by being the heirs to the tunnel after a century but by then it would probably be superseded by some form of flying motor car. It seems highly doubtful if the present generation would be willing to help a future one in such a nebulous way.

Should then the idea of a Channel link be dropped? The answer from the point of view of a commercially viable venture would appear to be "Yes."

But surely the subject should be examined in a wider context. A cross-Channel link is desirable for a number of reasons, not merely because it might be a sound commercial proposition. To enumerate but three:

(i) It is politically desirable for the UK to be linked more closely to the Continent of Europe.

(ii) It is desirable from the point of view of convenience to travellers.

(iii) It is economically desirable

(*a*) On a long term basis, because of the broad long term advantages to the economics of countries on both sides of the Channel.

(*b*) As a commercial venture, as viewed by the Channel Tunnel Study Group.

Such a link should be studied by the governments themselves or appointed agencies. Economic considerations, though important, should not predominate. A road/rail or simply a road link would have great advantages over a rail link and the difficulties of ventilation are by no means insurmountable. A bridge might well come into its own with perhaps six or seven traffic lanes. Such a bridge has already been discussed in an article in ENGINEERING of 8 April '60, vol. 189, p. 475. It is however an expensive proposition.

ROAD AND RAIL

Alternatively, a tube could be constructed which could accommodate both rail and road. Tube schemes have been mooted for well over a century but the early ideas were those of visionaries and could hardly be taken seriously. More recently, a proposal was made by G. P. J. Prevost de Saint-Cyr in 1929, which envisaged floating out concrete tubes into the Channel and sinking them into position by cables pulling on heavy weights on the Channel bed. Though some of his ideas are ingenious, they are hardly practical, bearing in mind the magnitude of the

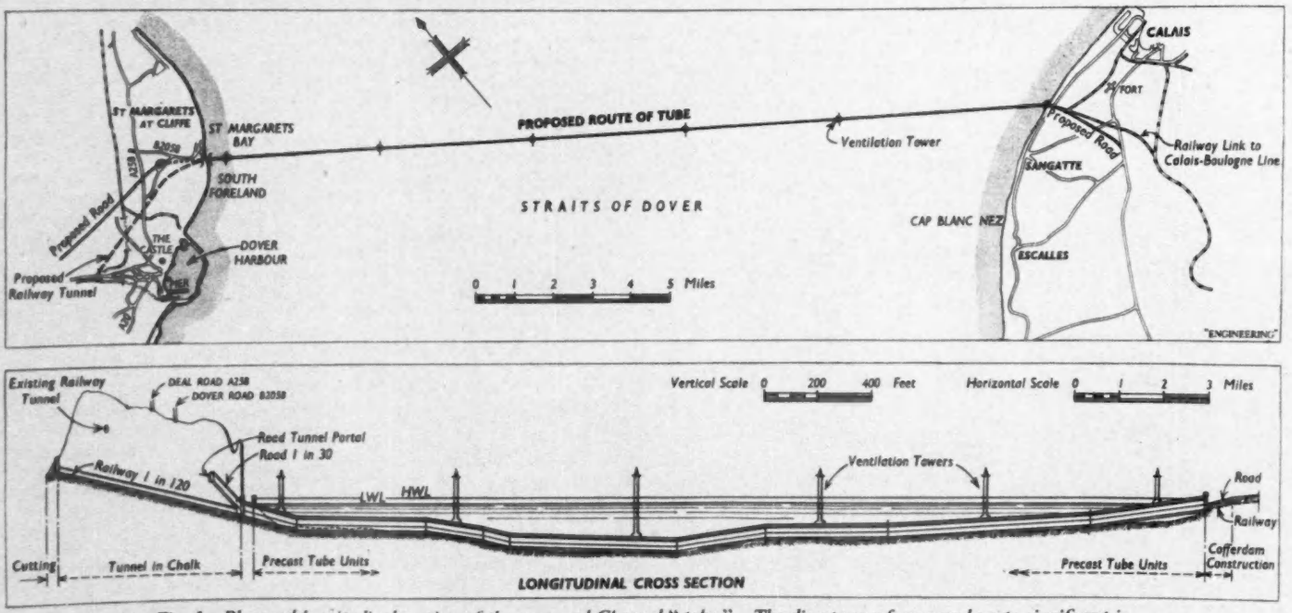


Fig. 1 Plan and longitudinal section of the proposed Channel "tube." The directness of proposed route significant is.

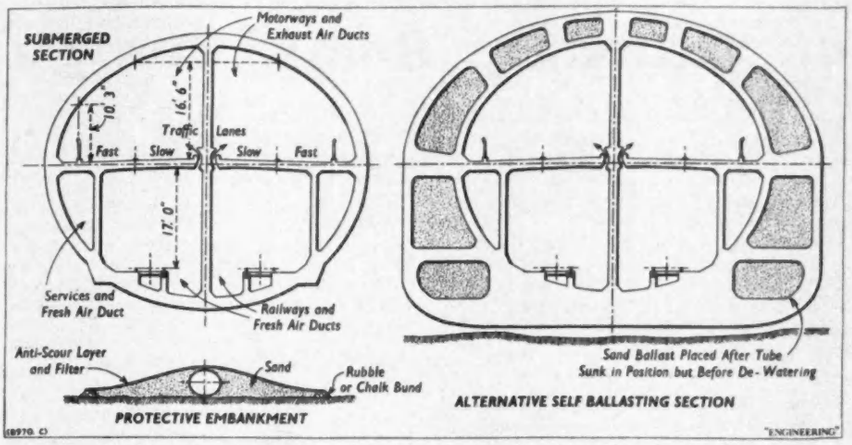


Fig. 2 Alternative cross-sections of the tube, showing disposition of road and rail tracks.

forces involved, not least of which are the Channel gales.

An outline of a proposal that might well lead to a practical method of construction is illustrated in Fig. 1. The tubes Fig. 2 are 300 ft long by 2 ft thick and are made up of elements (say 8 or 10 ft long) cast on a horizontal platform in steel moulds probably using vacuum concrete (see Fig. 3). As each element is cast, it is brought into a vertical position and pushed along rails on rollers until the requisite number are assembled. Cables are hauled through holes cast circumferentially in the elements which are pulled together and stressed. The joints between the elements are designed so that after stressing they will be perfectly watertight. Bulkheads would be fitted in the ends of the tube. After launching, the tubes would be water-ballasted ready for towing into position and lowering. If necessary, they would be sunk in a sufficient depth of water and left until required, when they could rapidly be blown up by compressed air. This is an important point, as the tubes would be made on an all the year round programme, whereas it would probably be best to concentrate the sinking operation into the summer months.

Pads on which to land the ends of the tubes would be prepared by means of spud pontoons—these pads, consisting of rubble mounds with an aggregate topping, would be finished off to correct level by means of a revolving blade or similar screed. In the deep part of the Channel it is envisaged that these pads might be placed on the sea bed without any dredging whereas where the Channel is less deep trenches would be dredged and the pads placed in the trench (though dredging would be limited to a comparatively small amount in view of the difficulty and expense of dredging chalk). Depending on the nature of the ground, it might be possible to incorporate short legs in the ends of the tubes and dispense with pads.

The concrete tube would be floated into position above its final resting place. The lowering would be controlled accurately by means of a system of spud pontoons, as illustrated in Fig. 4. During the lowering operation, the tube would be given a small negative buoyancy by controlling the water ballast. On approaching its final position, links would engage with trunnions cast into the collar of the tube already placed, thereby guiding the tube being placed for the last few feet, so that the spigot comes accurately into position in the socket.

A method of securing a permanent watertight joint between the tubes is illustrated in Fig. 5. A rubber washer is used to obtain a temporary watertight joint and subsequently caulking and grouting provides permanent tightness. The spud pontoons used for controlling and placing the tubes are leapfrogged from tube to tube.

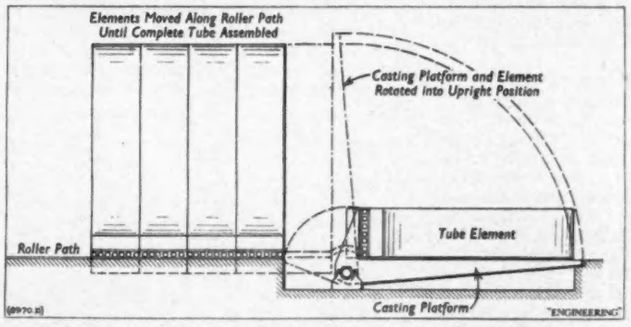
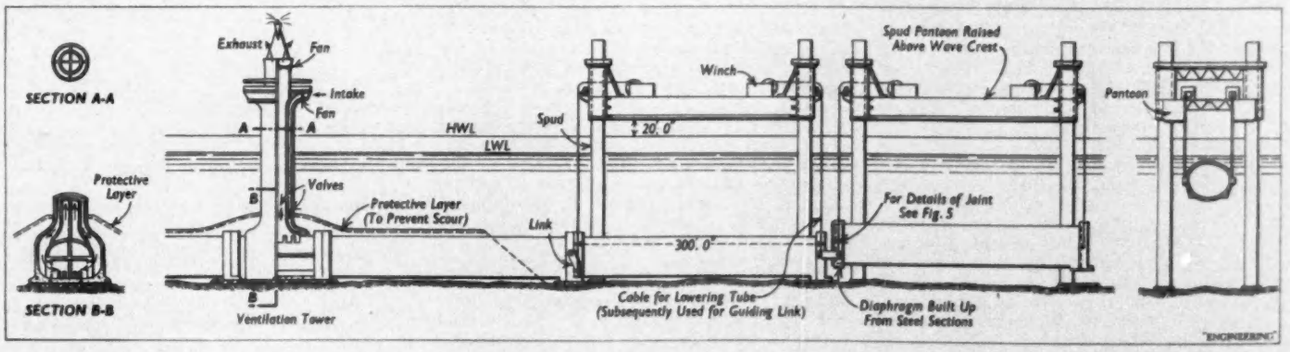

Elements Moved Along Roller Path Until Complete Tube Assembled
Casting Platform and Element Rotated into Upright Position
Tube Element
Roller Path
Casting Platform
"ENGINEERING"

Fig. 3 (Left) Method of casting the tube elements.

Fig. 4 (Below) Placing the tubes using spud pontoons, and cross-section of the fan towers.



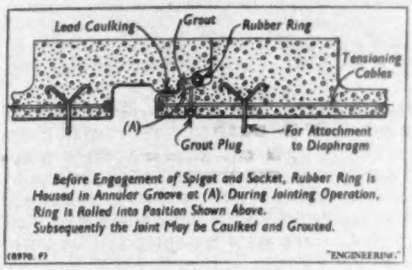

Lead Caulking
Grout
Rubber Ring
Tensioning Cables
(A)
Grout Plug
For Attachment to Diaphragm
Before Engagement of Spigot and Socket, Rubber Ring is Housed in Annular Groove at (A). During Jointing Operation, Ring is Rolled into Position Shown Above.
Subsequently the Joint May be Caulked and Grouted.
"ENGINEERING"

Fig. 5 Cross-section of the joint between tubes.

Behind the pontoons a sand blanket, suitably protected against scour, is placed over and around the tubes after which they are dewatered. This sand blanket has two functions: to prevent the tunnel from being displaced and to protect it from shipwrecks or submarines. A considerable amount of sand is necessary, but plenty is to hand in the Goodwin Banks which should provide a cheap source.

Alternatively, a section such as is shown in Fig. 2 may be used. This section is self-ballasting and would be less expensive to construct but more vulnerable to submarines: though it should be possible to prevent such vessels diving within a controlled area on either side of the line of the tunnel.

FAN TOWER VENTILATION

Ventilation is relatively easy with a tube as compared with a tunnel in the lower chalk, because fan towers can be much more readily and inexpensively constructed in the case of the tube. Such towers would be fabricated in the form of floating caissons and floated out and placed over special sections of the tube (see Fig. 4). The most economic distance apart needs considerable study but probably four miles would be reasonable. The power required to ventilate a tunnel from towers so placed would not be extortionate. The cross-section of such towers would be kept to a minimum within the wave range and automatically closing bulkheads would be fitted in each air duct so that in the very unlikely event of major damage causing an inrush of water it would not flood the tunnel. The ventilation system would be of the semi-transverse type, fresh air being blown into the lower half of the tube which is also used for rail traffic and foul air being drawn out from the top half.

A feature of the foregoing proposals is that the whole of the work is done without the necessity of employing divers, except perhaps for inspection purposes.

Rough estimates of cost seem to indicate that a tube construction would be by no means excessive and should not greatly exceed the £100 million mark. It is not unlikely that it would be found, on making a study of the cost, to be as cheap if not cheaper than a tunnel through the lower chalk and it would have one great advantage: one would face one's difficulties early, before embarking on any substantial expense, whereas a tunnel might be flooded out during the excavation of the last mile.

New Scope for Utilising Solar Energy

Between the latitudes 45° N and 50° S sufficient radiation is received on the earth's surface to warrant the direct utilisation of solar energy. Flat-plate and focusing heat collectors are currently in use.

By Stephen A. Vincze, Dipl. Ing., M.I.E.E., A.M.N.Z.I.E.

Consulting Engineer, Wellington, New Zealand

ALL ENERGY used on our planet can be traced back to the sun. The principal manifestations of solar energy are light, heat, running water, wind, electricity and photosynthesis. Solar light and heat are readlily available nearly everywhere; one only has to catch it. Some ways of catching it are described in this article, which is based on a paper read by the author before the Ninth Science Congress, Wellington, 1960.

At present, some 30 solar steam plants are in operation in Italy and a 1,000 kW solar electricity generating plant is under construction in Russia. By 1951 there were more than 50,000 solar warm-water plants in use in Florida saving 150,000 kWh electricity per day. In Australia, North Africa, Italy and the United States about 15,000 people depend on solar distillation plants for their drinking water. It is planned to heat several million buildings by solar means in the USA. Solar melting furnaces are in operation in the Pyrenees, in Algeria and in the USA.

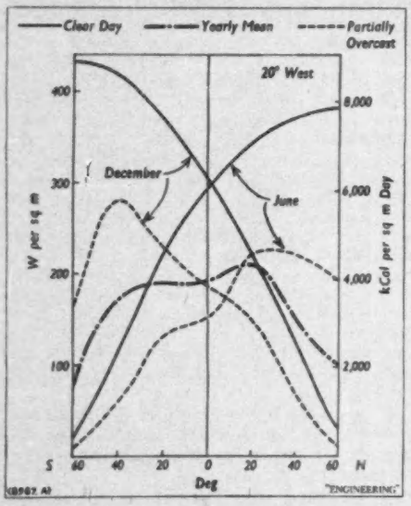


Fig. 1 Daily average values of the solar energy flux received on a horizontal surface at sea level.

By 1958 there were over 250 patent applications for the utilisation of solar energy in existence and the Stanford Research Institute in California had over 6,000 articles listed on the subject.

QUALITY AND QUANTITY

The sun loses some 4×10^6 tons per sec of its mass, equivalent to about $4{,}000 \times 10^{14}$ GW or to $3{,}500 \times 10^{18}$ GWh per year. The temperature and the intensity of radiation at the surface of the sun are estimated at 6,000 to 7,000° C and at 70,000 to 80,000 kW per square metre.

The radiation intensity at the outside boundary of the earth's atmosphere—the so-called solar constant—amounts to barely 1·425 kW per sq. m, a figure repeatedly corrected in recent years. The total radiation reaching the earth's surface amounts to some 60×10^6 GW or 525×10^6 GWh per year; a mere one half of a thousand millionth ($0{\cdot}5 \times 10^{-9}$) of that emitted by the sun.

Of the radiation reaching the earth 9 per cent is in the ultra-violet range, 41 per cent in the visible range, and 50 per cent in the range of heat waves. About 99 per cent of the sun's rays cover the 0·25 to 3 micron range. At sea level on a clear day the earth's surface receives 855 to 1,000 W per sq. m in direct radiation. Approximately half of the diffused radiation from the atmosphere reaches the earth as well. At low elevations of the sun the intensity of the diffused radiation is nearly equal to that of the direct radiation. According to the Paris Observatory, the incident solar energy received at their Park Street Institute amounts to 900 to 890 W per sq. m. The peak of the Monte Rosa receives 1,230 W per sq. m, Kew 940 W per sq. m.

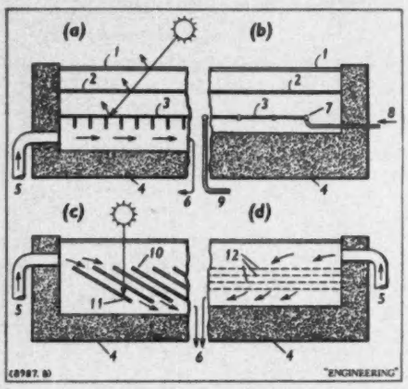


Fig. 2 Flat-plate heat collectors for air or water heating: (a, c and d) air heaters; (b) water heater; (a and b) double glass; (c and d) single glass insulation on the irradiation side.

1. Upper glass plate
2. Lower glass plate
3. Heat collector plate
4. Heat insulated frame
5. Air inlet
6. Air outlet
7. Pipe type heat collector
8. Water inlet
9. Water outlet
10. Air guide and heat exchanger vanes made of glass
11. Blackened heat-absorbing part of 10
12. Black gauge heat absorber

Measurements carried out by the writer in Wellington, New Zealand (May, 1958) give 1·2 kWh per sq. m and 4·75 kWh per sq. m or 200 W per sq. m and 950 W per sq. m respectively. The lower values refer to overcast sky, the higher values to clear sky. Both figures have been measured on a surface inclined at 60° to the horizontal.

The orbit of the earth around the sun is slightly elliptical and the axis of the earth slightly inclined to the plane of the orbit. The earth is approx. 3·5 per cent further away from the sun in summer than in winter. The Northern Hemisphere is 23·5° turned away from the sun in winter, 23·5° turned towards the sun in summer, causing the variations in the duration of the day and of the various seasons. It is interesting to note that at latitude 20° North, the earth receives 10 per cent more radiation than at the equator and at latitude 40° South about 12 per cent more than at latitude 40° North. All the earth's surface between latitudes 40° North and 42° South receives 80 to 110 per cent of the radiation received at the equator and is suitable for the direct utilisation of solar energy. Southern Europe, the greater part of China, all of India, Africa, Australia and New Zealand, all of the USA south of New York and nearly all of South America, are within these latitudes.

Fig. 1 shows the daily average values of the solar energy flux received on a horizontal surface at sea level as a function of the geographical latitude. Fig. 1 reveals that at latitude 40° South a horizontal surface will receive 3,700 kcal per square m per day (4·3 kWh per sq. m per day), at latitude 40° North 3,000 kcal per sq. m per day on the average throughout the year. For best results at latitude 40° North, heat collectors should be inclined approximately 25° to the horizontal in summer, and 55° in winter.

For preliminary calculations it may be assumed that in New Zealand during the hours of sunshine 700 W per sq. m incident solar power is available on the average, or 1,400 kWh per sq. m per year. Putting it another way, the solar energy reaching the earth's surface in New Zealand amounts to $5{\cdot}6 \times 10^6$ kWh per acre per year, equivalent to 1,000 ton coal per acre per annum.

FLAT PLATE AND FOCUSING

The heat collectors used with solar plant may be divided into two main groups: flat-plate heat collectors and focusing heat collectors.

Flat-plate heat collectors are used up to temperatures of the order of 100° C, mainly for air and water heating, distillation, and similar purposes. There is a variety of designs in existence, all of which are based on the employment of a "black body" as heat collector, contained in some sort of heat insulated framework. Some solutions are shown in Fig. 2.

Though the glass plate reduces the intensity of the transmitted solar radiation by 10 to 25 per cent, it behaves in regard to longwave heat radiation as an insulator, and prevents the loss of heat to the firmament.

Suitably shaped mirrors reflect and collect the sunrays in the focal zone. The ratio of mirror area to focal area is the "concentration grade." Trough-type mirrors are used for small, circular paraboloid mirrors for large concentration grades

Mirrors are made either to follow the sun directly, or are fixed to receive the sunrays through directing mirrors—heliostats—following the sun. Aluminium and glass are mostly used for making the mirrors. Typical arrangements are shown in Fig. 3, and the dates of their first application are given. Table I summarises the performance data of focusing mirrors.

APPLICATIONS

Water Heating Plants.—In sunny countries it is possible to obtain warm water at temperatures exceeding 50° C during three quarters of the year by means of flat-plate collectors. It was possible even near London to obtain on two-thirds of the days during the five summer months water of 55° C temperature. Seven experimental water heaters were installed at

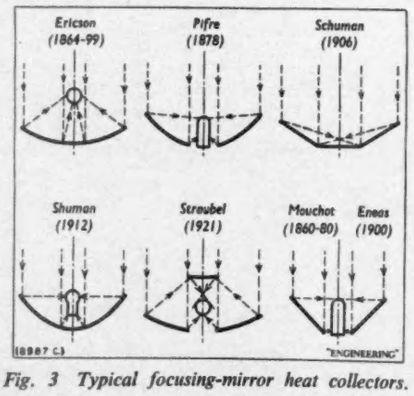


Fig. 3 Typical focusing-mirror heat collectors.

TABLE I:—*Performance Data for Focusing Mirrors*

Mirror shape	Concentration grade	Obtainable temperature rise (° C)
Trough	10 to 200	300 to 1,000
Circular paraboloid	200 to 28,000	1,000 to 3,000

laboratories throughout Australia to gain field experience and performance data. Each heater included an insulated 70 gallon water storage tank with a built-in 2 kW electric booster and two flat-plate solar heat collectors of a total area of 45 sq. ft.

Each morning approximately 45 gallons of water at 135° F were discharged from the tank. The mean yearly contribution of the solar energy under these conditions was 60 to 80 per cent of the total energy required, depending on the locality.

Water Distillation.—A distillation plant for the preparation of drinking water from sea or from brackish water operates as follows. The sunrays are directed through glass plates on to a shallow layer of raw water. The water evaporates, the vapours condense on the glass and are collected in the bottom troughs. Five litres of water per sq. m per day can be obtained with such plant. Evaporation in several stages, utilising a solar boiler, permits the water yield to be increased. A Russian plant supplies approximately 1,000 litres sweet water during ten hours of sunshine at latitude 40° N.

Space Heating.—Solar space heating can be provided comparatively simply, by using warm water or hot air as heat carrier. Flat-plate heat collectors are generally used. It is desirable to provide heat storage for a whole week, but essential to provide for at least 24 hours in order to remain reasonably independent of the weather. Also some sort of additional heating is required.

Even the provision of a small amount of storage capacity results in a large decrease in the additional energy requirements. On the other hand, water storage capacity in excess of 100 to 150 kg per sq. m of collector area causes but negligible further reduction in the amount of additional energy required.

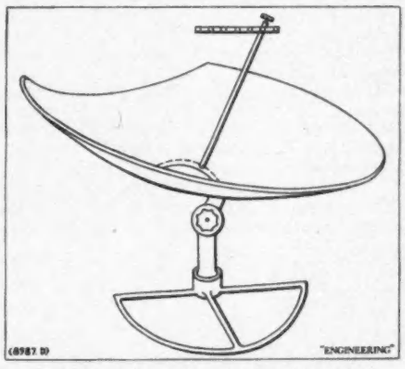


Fig. 4 Solar cooker developed in India.

In localities above 40° North or below 42° South it is advantageous to provide only two-thirds to three quarters of the necessary heat collector area and to supply the remainder of the heat required by some additional means.

A solar heated office building of 4,300 sq. ft gross building area combined with a heat pump installation for air conditioning uses flat-plate aluminium heat collectors, integral with the tubes, having 790 sq. ft total area. A 6,000 gallon water storage tank is provided underground. The heaters comprise a combination of floor and ceiling panels and of air heaters, all heated by 95 to 100° F water. The floor panels are used for heating only, the ceiling panels and air heaters for heating and cooling. A 7·5 ton chilled water unit serves as heat pump.

A house situated at Denver (Colorado) uses two 3 ft diameter 16 ft high fibreboard cylinders holding 10 tons coarse gravel for 24 hour heat storage. Oil heaters provide the stand-by heat. Twenty heat collector panels each 6 ft high by 2 ft 6 in wide, afford a total heat collector area of 300 sq. ft. The maximum collector temperature reaches 250° F even in winter.

Air Conditioning.—The heat of the sun may be used for cooling, by means of an absorption system. For air conditioning, simple flat-plate collectors may be used.

Solar Cookers.—Temperatures around 300° C are required for cooking. A 350W solar cooker developed by M. L. Ghai, National Physical Laboratories of India, has a mirror area of 1 sq. m. The mirror, shown in Fig. 4, must be so directed that the shadow of the pot sitting on the grid located in the focal zone of the paraboloid mirror will fall through the hole provided at the bottom of the mirror.

Solar Power Plants.—With a focusing collector having a concentration grade of 100, about 800° C can be obtained in the focal zone. Thus, for a solar power plant with an average solar radiation intensity of 700 W per sq. m, a collector efficiency of 80 per cent and a thermal efficiency of 15 to 30 per cent of the heat engine, a collector area of 12 to 6 sq. m. per kW would be required.

The plants shown in Fig 5 use a simple flat-plate collector for preheating the heat carrying medium. The focusing mirror acts as the boiler and raises and superheats steam to the required admission value. Whereas the 45 kW steam plant in Egypt used a collector surface of 34 sq. m per kW, a small 1·3 kW plant built by C. G. Abbot in 1945 requires only 8 sq. m per kW. His most efficient solar power plant design requires a 10 ft diameter mirror for 2 horse-power or 4·9 sq. m per kW.

Fig. 6 shows the Russian solar power station now under construction for a town of 20,000 inhabitants on the shores of the Black Sea. The solar boiler is located on the top of the 40 m high structure. It supplies 13 tons of steam per hour at 16 atmospheres and 350° C for a 1,000 kW back-pressure turbine-alternator.

The back-pressure steam will be used in winter for district heating, in summer for the production of 19 tons of ice per hour or 44 cubic metres of cold water. The plant capacity is based on about 1,800 hours per year of sunshine. The focusing mirrors have a total area of 20,000 sq. m and will be mounted on trolleys. The latter move on concentric rails. The sunrays will be concentrated on a heating surface of 8 by 15m, or 120 sq. m area.

The largest solar furnace to date is at Mont Louis in the Pyrenees. The parabolic mirror consists of 3,500 curved elements of 1·5 mm thick silvered window glass, has an area of 90 sq. m, a focal length of 6 m, and receives the sunrays through a 135 sq. m directing mirror (heliostat). The furnace output is 75 kW with maximum temperature over 3,000° C in the focal area. The heliostat comprises 3,500 single flat elements in a common frame.

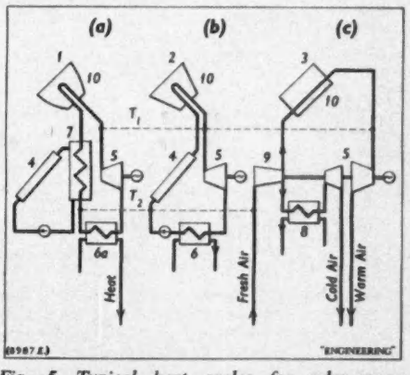


Fig. 5 Typical heat cycles for solar power plants: (a) dual vapour cycle; (b) classical steam cycle; and (c) hot air cycle.

1. Parabolic mirror
2. Conical mirror
3. Trough type mirror
4. Flat plate heat collector
5. Turbine
6. Condenser
6a. Liquefier
7. Heat exchanger
8. Cooler
9. Compressor
10. Boiler

Solar Battery.—The solar battery recently developed by the Bell Telephone Laboratories can supply 110 W per sq. m or 90 W per kg weight. Its efficiency of solar energy conversion —which a few years ago amounted to barely 5 per cent—has lately been raised to 11 per cent. The battery consists of thin silicon wafers about the size and thickness of a safety razor blade. A battery comprising 432 silicon wafers built in 1956 yields 9 W at 26 V (0·60 V per cell) at full sunshine and is used for charging a nickel-cadmium storage battery.

EFFICIENCY AND ECONOMICS

Nature's efficiency of conversion of solar energy into running water is very low; barely 0·0025 per cent. However, the conversion of the energy of this water into electricity can be accomplished with an efficiency of approximately 90 per cent. In the growth of plants sunlight is converted into chemical energy by photosynthesis with an efficiency of about 0·5 to 1·5 per cent. This energy can be converted into heat by burning, with an efficiency of 80 per cent, or into mechanical energy—via men and beasts—with an efficiency of 9 to 11 per cent. Solar energy can be transformed directly into heat or into mechanical and electrical energy with considerably higher efficiencies. (See Table III.)

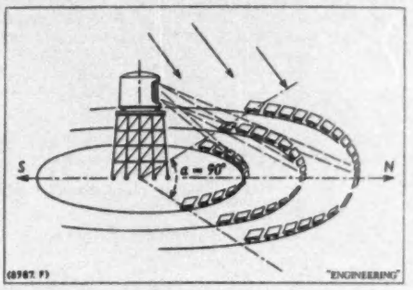


Fig. 6 Solar power station now building in Russia.

TABLE III:—*Efficiency of Solar Energy Utilisation*

Item	Energy conversion process	Efficiency, per cent
1	Solar energy into running water via natural evaporation	0·0025
2	Solar energy into wood, via photosynthesis	0·5–1·5
3	Solar energy into green fodder, via photosynthesis	0·25–1·0
4	Solar energy into heat by means of flat-plate collectors	50–60
5	Solar energy into heat by means of trough-type parabolic mirrors	45–55
6	Solar energy into heat by means of parabolic mirrors	65–82
7	Wood into heat by burning	70–80
8	Running water into mechanical energy via water turbines	95
9	Heat into mechanical energy through heat engines	5–40
10	Green food into mechanical (muscular energy) via men and beasts	9–11
11	Mechanical energy into electrical energy via electrical machines	95
12	Solar energy into electrical energy via solar battery	10–13

A solar heater designed for 1 kW useful heat output could supply in New Zealand 2,000 kWh per year, worth (in Wellington, New Zealand) £6·7 at domestic electric tariff, £24 at commercial space heating tariff, £17 at industrial water heating tariff (small installations), £10 at industrial water heating tariff (large installations). These amounts capitalised at 5·5 per cent compound interest, would permit the investments shown in Table IV.

TABLE IV.—*Permissible Investment for Solar Heater* (£ per kW)

Investment paid off in	5 years	10 years	15 years
In the case of domestic electric tariff	28·5	51	67
In the case of commercial space heating tariff	106	189	250
In the case of industrial water heating tariff	75	132	170(*)
	43	75·5	100(†)

(*) For small installations. (†) For large installations.

The solar part of the hot air heating plant of a $40,000 five-bedroomed house is expected to cost $1,000, or $50 per kW (£17·8 per kW) by the late 1960's and it is claimed that in Colorado as well as in New England some 80 to 85 per cent of the total heat requirements of a building can be met by solar heating. The above figures reveal that solar heating plants are both technically and economically feasible, particularly for commercial and industrial installations.

Petrol Injection Stimulates Small Cars

Fuel injection systems have been found to give better performance and efficiency in racing cars. A petrol injection unit suitable for ordinary small cars has now been produced.

A PETROL injection system that can be fitted in ordinary cars instead of a carburettor has been produced by Simms Motor Units Limited, East Finchley, London. It can give increased power and improved fuel economy. The system costs more than the carburettor it replaces, but less than most other petrol injection systems. Simms reduce cost by using only one injection nozzle, in the intake manifold, instead of an injection nozzle in each cylinder. Consequently, injection pump design is much simplified.

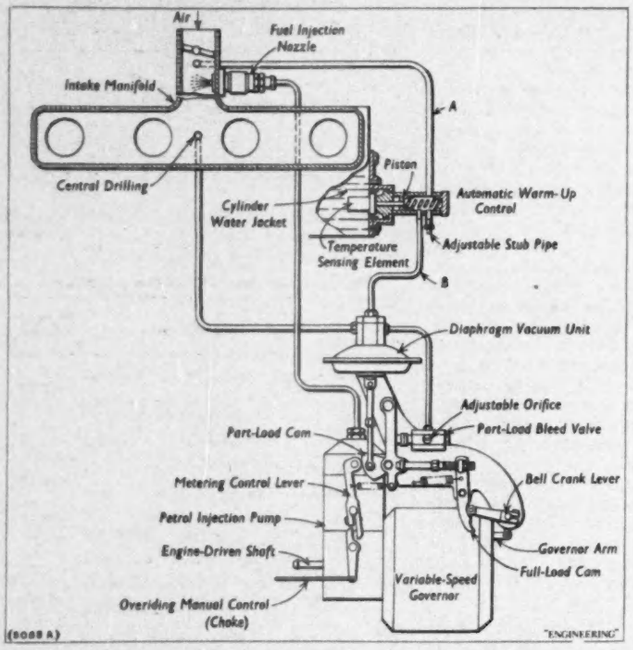


Fig. 1 Two cams govern the position of the metering control lever, and so control the amount of fuel injected.

Petrol injection systems in general give improved performance over carburettors because they lead to increased volumetric efficiency. This results from the absence of an air intake venturi, from the fact that the air intake manifold and valve overlap can be designed with regard only to achieving maximum air charge (fuel distribution is taken care of by the injection nozzle), and from the fact that the introduction of an atomised charge directly into the cylinder has a greater cooling effect than a partially vapourised charge arriving via the air intake manifold. In achieving low cost and simplicity by fitting the injection nozzle in the intake manifold, Simms have had to pass over the last two advantages to a large extent. Nevertheless, bench tests with an 845 cu. cm engine fitted with their system have given savings in specific fuel consumption of the order of 16 per cent.

The application of the system to an engine with a capacity of only 211 cu. cm per cylinder is of particular interest as the fuel requirements per cycle are as small as 5 cu. mm. The pump developed for this purpose uses a short plunger movement of 0·015 in to deform a synthetic rubber ring that produces a rapid discharge of petrol. An injection period of only 10° of crankshaft rotation is obtained. This allows the injection timing to be chosen so as to promote complete scavenging of the inlet manifold for each cycle.

The camshaft lifting the pump plunger is driven at half engine speed and is supplied with a lobe for each cylinder. Pump output, or metering, control is by a lever adjustment which lengthens or shortens the effective pumping stroke.

MONITORED LOAD DEMAND

A control system is required to adjust the metering control lever automatically so that the amount of petrol injected is correct for the particular conditions of speed, load, and temperature of the engine at any instant. The system that has been developed is shown in the illustration. Load requirements are monitored by reference to manifold pressure, speed by reference to the movement of the arm of a variable-speed governor driven from the same shaft as the pump, and temperature by reference to the movement of a temperature-sensitive element located in the cylinder-head water jacket. The manual controls associated with the system are the normal accelerator control (throttling the air supply to the intake manifold) and a "choke" control for cold starting, which is in fact an over-riding manual control for operating the metering lever of the fuel pump—it can give up to 140 cu. mm per injection, if necessary.

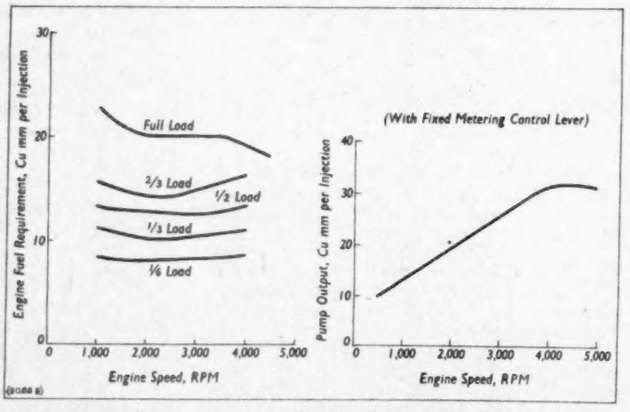


Fig. 2 The control system associated with the petrol injection pump adjusts the pump output curve to approximate to the fuel requirement curve.

During full-load operation, after the initial warm-up period, movement of the metering lever derives from the movement of the governor arm. As engine speed increases the arm extends further out of the governor casing, operating a bell-crank lever which in turn bears through a roller bearing on to a cam. The cam is shaped so that its movement transmitted through a connecting link to the metering lever of the pump results in the correct amount of fuel being injected at the particular engine speed. The way this amount varies is shown in Fig. 1. Anti-clockwise movement of the metering control increases fuel delivery per cycle.

As can be seen from the graph, the way fuel required varies with speed is different at different loads. For part-load operation a second cam comes into play: it is linked to the diaphragm of a vacuum unit. The chamber above the diaphragm is connected by piping to a central drilling in the air intake manifold and to two other units which come into operation at low engine temperature or high speed. The diaphragm of the pressure unit is spring-loaded in a downward direction and is sensitive to manifold pressure. Variations in manifold pressure—closely related to engine load—cause the diaphragm to move up and down. Such motion, transmitted through a simple link to the part-load cam, adjusts the pump output control lever in accordance with engine load.

PART-LOAD OPERATION

As can be seen from the graph, the fuel requirement at engine speeds above 2,500 r.p.m. for part-load operation differ substantially from that of full load. To take account of this, which means that fuel has to be increased with speed at any constant part-loading of the engine, a second governor-controlled linkage operates a part-load bleed valve. This valve is one of the units connected to the manifold side of the pressure-sensitive diaphragm. When open it communicates with the atmosphere through the adjustable orifice. It serves to modify the level of depression in the vacuum unit and lowers the position of the part-load cam to provide the necessary enrichment at high speeds.

Automatic enrichment during the warming-up period of the engine is also provided. A temperature sensitive element in the cylinder head water jacket is connected to a piston unit capable of giving a movement of 0·550 in from 100° F to 170° F against a spring pressure of 17 lb. This is used to adjust the pressure above the pressure sensitive diaphragm so that the part-load cam is again lowered to provide the necessary enrichment

In situations when the engine is cold, the piston in the automatic warm-up unit is forced to the left and all the pipelines to the unit are uncovered. This means that with the throttle valve set at normal idle speed opening, extra air is supplied to the engine side of it through pipe A from the adjustable stub, which is open to atmosphere. At the same time, pipe B is also connected to atmosphere through the stub pipe, and this causes a rise in pressure in the pressure-sensitive unit and consequently an increase in the fuel delivered. The extra air and fuel result in a fast idle. As the engine warms up, the piston moves to the right. At a predetermined temperature it cuts off the enrichment by sealing pipe B. At a somewhat higher temperature it cuts off pipe A to establish normal idle speed and mixture strength.

Documentary Survey

THE number of reports and memoranda that are released by the United Kingdom Atomic Energy Authority continues to be large, and the problem of giving the maximum access to the many readers of such reports requires careful organisation. The situation is complicated by the extent to which the Authority is decentralised, the information being made available and published by several independent sources.

Subdivisions of the UKAEA

The functions of the organisation may be outlined in the following way.

The London Office directs the policy and coordinates the work of the UKAEA under the Authority Members and executive committee, and controls certain broad functions that affect all Groups.

The Authority Health and Safety Branch advises the Authority Members on health and safety policy, assesses and and inspects reactors, plants and laboratories.

The Development and Engineering Group (created in July, 1959, from the former Industrial Group) with headquarters at Risley, looks after development, design and construction of nuclear reactors and associated plants; engineering consultant work; and general engineering design and construction of all major UKAEA building projects.

The Production Group (also created from the Industrial Group in 1959) with headquarters at Risley, includes uranium enrichment and fuel element production; irradiated fuel element processing; and reactor operation.

The Research Group, with headquarters at Harwell, conducts research into all aspects of atomic energy and handles the production and distribution of radioisotopes.

The Weapons Group at Aldermaston carries out research and development work on atomic weapons and a number of associated problems.

Depository Libraries

The Authority have arranged for microcopies to be taken of all unclassified and declassified documents issued after 1947. The accompanying table, taken from the *Guide to UKAEA Documents*, shows where the documents, together with the United States and Canadian unclassified reports, are available for public use at Depository Libraries. In addition to the number of official depositories listed in the table for the United Kingdom, there are 36 foreign countries and four international organisations to which the documents are sent. The majority of these countries reciprocate the gesture by sending their own reports.

Methods of Informing the Reader

The Authority does not publish an abstract journal but many of its publications are summarised in certain specialised abstracting journals. Current unclassified reports, including those which have been declassified and reprinted, are recorded every month in the UKAEA *List of Publications Available to the Public*. It is compiled and published on behalf of all Groups of the Authority, and may be mailed regularly to any who request it. Four annual cumulations are now available—the first being for 1956. There is a limited coverage for the period prior to 1956. If it is considered that there is sufficient widespread demand, select or comprehensive subject bibliographies are prepared and are obtainable through the usual channels.

Classified Documents

Under certain circumstances classified documents may be supplied to Government departments, industry and research organisations. Apart from defence considerations, which still restrict access to some information, a large amount of the Authority's development and design work has a commercial value, and is not released except under negotiated agreements.

Table giving Availability of Atomic Energy Research Reports in Depository Libraries. The Collections contain Reports issued by the Authorities from the Dates given.

Depository Library holding reports issued since the dates shown opposite	United Kingdom Atomic Energy Authority						US Atomic Energy Commission	Atomic Energy of Canada Ltd.
	Authority Health and Safety Branch (AHSB)	Development and Engineering and Production Groups (DEG) (PG)	(Former) Industrial Group (IG)	Research Group (AERE) (RCC)	Research Group (AEEW)	Weapons Group (AWRE)		
Science Museum Library, London, SW7 †Central Library, Surrey Street, Sheffield 1	September 1959	July 1959	November 1955–July 1959	1952	August 1959	June 1957	1952	1952
†Central Library, Ratcliff Place, Birmingham 1 †Mitchell Library, North Street, Glasgow, C3 †Central Library, William Brown Street, Liverpool 3 †Central Library, St. Peter's Square, Manchester 2 †Central Library, New Bridge Street, Newcastle upon Tyne 1	September 1959	July 1959	November 1955–July 1959	November 1955	August 1959	June 1957	March 1956	March* 1956
†Central Library, High Street, Acton, London, W3 Central Library, College Green, Bristol 1 †Central Library, Albion Street, Kingston upon Hull †Central Library, Calverley Street, Leeds 1 Department of Industrial and Forensic Science, Verner Street, Belfast, Northern Ireland	September 1959	July 1959	November 1956–July 1959	November 1956	August 1959	June 1957	January 1957	January 1957
†Public Library, South Sherwood Street, Nottingham	September 1959	July 1959	December 1957–July 1959	December 1957	August 1959	December 1957	January 1958	January 1958
Central Library, George IV Bridge, Edinburgh 1 Central Library, The Hayes, Cardiff Reference Library, Bishop Street, Leicester County Library, County Education Offices, Stafford	September 1959	July 1959	January 1958–July 1959	January 1958	August 1959			

* Liverpool has Canadian reports dating from 1952.
† Libraries holding microcopies of unclassified and declassified documents issued between 1947 and December 1956.

Nuclear Science Abstracts

The purpose of the Nuclear Science Abstracts, a half-monthly publication issued by the USAEC, is to provide abstracts of the litcrature on nuclear science and engineering, as well as immediate and detailed indexes. The sources of the abstracts are taken from USAEC reports, university and other research organisations, translations, patents, books and articles appearing in technical and scientific journals. The abstract issues are available from the Superintendent of Documents, US Government Printing Office, Washington 25, DC. The latest publication is a culmination issue for the third quarter (July to September, 1960).

IAEA Publications

The third International Atomic Energy Agency *Publications Catalogue* has been released. Abstracts are given of all the recent publications of the Agency including proceedings from conferences that it has held.

World List of Institutions

In order to facilitate and foster the exchange of nuclear information between the Member States of the IAEA lists of institutions concerned with atomic energy in individual countries are being drawn up. In addition to those already published, four more have been completed—the Netherlands, New Zealand, Switzerland and the United Kingdom.

USAEC Civilian Power Programme

The United States Atomic Energy Commission has published the final volume of the eleven volume report on the Civilian Power Reactor Programme. The separate volumes of the report are available through the Superintendent of Documents, United States Government Printing Office, Washington 25, DC, at the prices indicated: Part I—Summary of Technical and Economic Status as of 1959 (TID-8516), price $1·00; Part II—Economic Potential and Development Programme as of 1959 (TID-8517), price $0·70; Part III—Book 1, Status Report on Fast Reactors as of 1959 (TID-8518(1)), price $1·00; Part III—Book 2, Status Report on Pressurised Water Reactors as of 1959 (TID-8518(2)), price $1·25; Part III—Book 3, Status Report on Aqueous Homogeneous Reactors as of 1959 (TID-8518(3)), price $1·25; Part III—Book 4, Status Report of Heavy Water Moderated Reactors as of 1959 (TID-8518(4)), price $2·25; Part III—Book 5, Status Report on Boiling Water Reactor Technology as of 1959 (TID-8518(5)), price $0·60; Part III—Book 6, Status Report on Sodium Graphite Reactors as of 1959 (TID-8518(6)), price $1·00; Part III—Book 7, Status Report on Organic-Cooled Power Reactors as of 1959 (TID-8518(7)), price $2·25; Part III—Book 8, Status Report on Gas-Cooled Reactors as of 1959 (TID-8518(8)), price $0·55; and Part IV—Plans for Development as of February, 1960 (TID-8519), price $0·25. An index volume for Part III is being prepared.

A related volume to the overall report "Power Cost Normalization Studies, Civilian Power Reactor Programme—1959" (SL-1674), is available from the Office of Technical Services, US Department of Commerce, Washington 25, DC, for $2·50. This volume, containing 164 pages of text, tables, graphs, and engineering drawings, deals with the cost estimates of the eight reactor concepts discussed in the volumes of Part III.

Radiation Chemistry Abstracts

The Selected Abstracts of Atomic Energy Project Unclassified Report Literature in the Field of Radiation Chemistry and Bibliography of the Published Literature (fourth annual supplement) noted in papers up to December, 1959, is now available. It may be obtained from HM Stationery Office price £3 4*s* 0*d*.

Nuclear Fusion

A new quarterly journal is being published by the International Atomic Energy Agency called *Nuclear Fusion* and sets out to promote and exchange information on plasma physics and controlled nuclear fusion research. All who read the journal are invited to provide comments and manuscripts. The first issue includes a comprehensive article reviewing the theory of wave phenomena in plasmas, and the basic theory is developed, taking into account coulomb collisions. There are two levels of description of plasmas which have received major consideration during the last decade. The first is based on the direct solution of the Boltzmann transport equation—usually referred to as the kinetic theory description, which has the merit of providing a more complete description of the dynamics of a plasma, but is mathematically more tricky. The second method is based on using a closed set of moment equations to characterise the behaviour of a plasma, which is usually referred to as the hydrodynamic or hydromagnetic description. It has the merit of relative mathematical simplicity and assists in the physical understanding of various phenomena. The article is divided into two parts—in the first the kinetic theory description is formulated and its relation to the hydrodynamic description established, and the resulting equations applied to a variety of wave phenomena. The second part, to appear in a later issue, will be devoted to a discussion of wave phenomena based directly on the kinetic theory

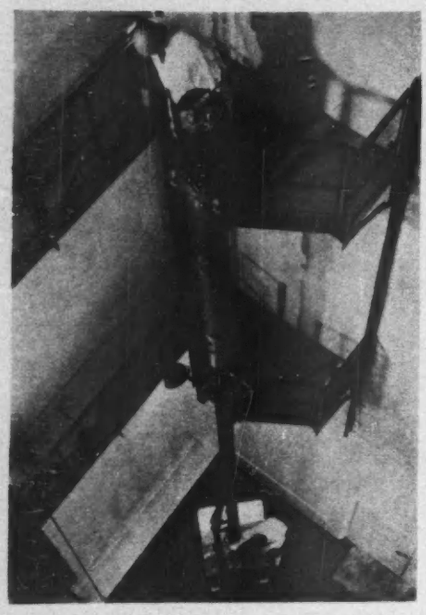


Fig. 1 Mechanism for adjusting the position of the charging chute to be used at Hinkley Point.

New Catalogue

A new publication has been prepared by the Central Office of Information in cooperation with the UKAEA. *A Guide to Information on Atomic Energy in Britain* is published by HM Stationery Office, priced 5*s* and contains a selected list of British books, periodicals, reports, films, photographs and display material originally compiled for specialised and prestige distribution overseas. It describes the latest nuclear developments in the United Kingdom.

Notes and News

Fuelling Charge Chutes for Hinkley Point

The first of eight fuelling charge chutes manufactured and tested by D. Napier and Son Limited to the order of the English Electric Company has recently been delivered for the Hinckley Point station. The initial design was by the English Electric Company, but manufacture and test has been controlled by the Special Projects organisation of Napiers, which is engaged on a number of contracts arising from the diversification programme of the company. In the reactor a fuelling charge chute will be inserted through a stand-pipe by the hole preparation machine until its lower end locates on a charge pan, the upper end being at pile cap level, giving an overall length of about 37 ft.

Locating Required Channel

The lower part of the tube is open on one side, and contains a jointed leg which can be moved outward from the tube, shown in Fig. 1. The whole of the lower part can also be rotated to any required direction. In operation, the fuelling machine is coupled to the top of the charge chute by a retractable connection. The charge chute motions are remotely controlled from the fuelling machine so that the end of the jointed leg may be positioned accurately over any channel in the particular charge pan. When the required channel has been located in this way, a fuel element may be lowered into the reactor by means of a grab, or a spent one may be removed by a similar operation.

Operational Mechanism

One of the fuelling charge chutes is shown in Fig. 2 on test in the clean facility which Napier use for this type of work. The lower section is supported by the dummy charge pan at floor level and the upper section by a simulated standpipe top. At the top of the upper section is the gearbox. In Fig. 2 a manually rotated drive shaft is shown, but in operation the shafts for positioning the chute and gas valve are rotated by drives from electric motors mounted on the fuelling machine. The leg is positioned by two concentric tubes that are driven by the gearbox at the top of the graphite shielded section. The outer of these engages with the lower section to rotate it, and the inner continues into the lower section and actuates the jointed leg by means of a recirculating ball jack. All these mechanical parts are of stainless steel, and no lubrication is used.

Details of Fabrication

The lower section of the tube is 23 ft long and 8 in diameter, and is made in two sections of cold drawn stainless steel by Talbot Stead Tube Company Limited. These are welded together, after which the side opening in the lower part is machined. The bore of the upper section is cylindrical, but the lower cut-away section is strengthened by having specially thickened sides, produced in the original drawing of this tube. Of the four tubes so far completed the average maximum deviation from straightness over the whole length is 0·180 in. Before assembly the lower tube is suspended in the stress-free position in which it is to operate, and its exact configuration in this position is measured, then removed from the vertical in a special transport and build stand designed to carry the tube without bending. It is only removed from the stand when in the vertical position for final assembly of the chute.

Reactor Note

Nuclear Power Station for Anglesey: The CEGB have decided to ask the Minister of Power and the local planning authority for consent to establish a nuclear power station at Wylfa in Anglesey having a capacity not exceeding 800 MW and with the aim of commissioning in 1967. This will be the eighth CEGB nuclear station if consent is granted.

Accelerator Note

Accelerator in a Doughnut: Work has begun on the building in the shape of a doughnut for the 12·5 GeV near Chicago. The Zero Gradient Proton Synchrotron (ZGS) will be used to accelerate "... all 30 presently known or anticipated subatomic particles" explained Dr. R. H. Hildebrand of the High Energy Physics Laboratory. It is anticipated that construction will finish in 1962, when the total investment will be approximately $42 million. A plan view of the site is shown in Fig. 3.

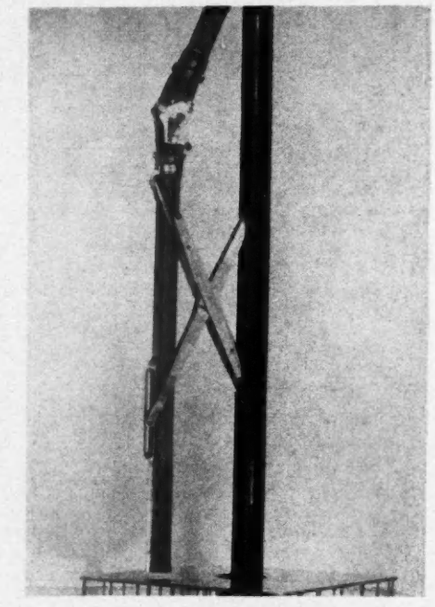


Fig. 2 Fuelling charge chute shown with manual drive; when in operation the drive will be replaced by electric motors.

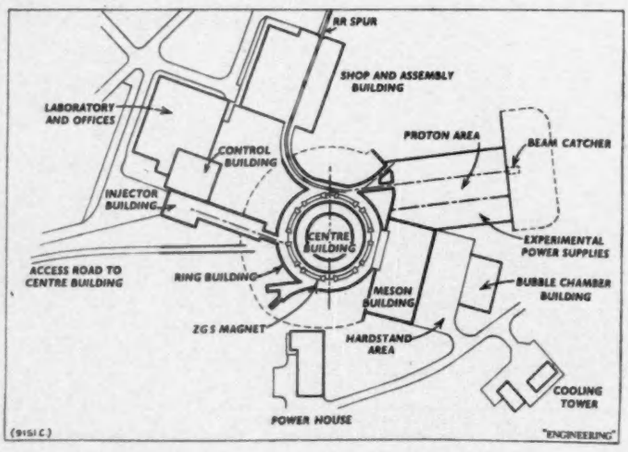


Fig. 3 Plan view of the 12·5 GeV Zero Gradient Proton Syncrotron being built near Chicago.

The

'Engineering' Appointments

Section

THE NUCLEAR POWER GROUP

requires

MECHANICAL ENGINEERS

The Group is now actively engaged upon the construction of four major nuclear power stations as well as designs for new plants in the United Kingdom and overseas. Applications are invited from qualified engineers for vacancies in the MECHANICAL DEPARTMENT.

The work will involve thermal performance calculations on gas cooled reactors including the specification of the fuel element cooling surface.

Candidates should have an engineering degree or equivalent qualification and some knowledge of heat transfer and fluid flow. Previous experience in a design organisation would be an advantage, but is not essential.

The Company operates a Contributory Pension Scheme and assistance with house purchase is given to married men.

Applications, giving full details of age, qualifications and experience, should be addressed to:—

THE PERSONNEL MANAGER,
THE NUCLEAR POWER GROUP
RADBROKE HALL,
KNUTSFORD,
CHESHIRE.

Quoting reference: E/MECH/17.

D 575

PUBLIC APPOINTMENTS

MIDDLESEX COUNTY COUNCIL
EDUCATION COMMITTEE
BRUNEL COLLEGE OF TECHNOLOGY
WOODLANDS AVENUE, W.3
DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the following posts:
(*a*) SENIOR LECTURER IN FLUID MECHANICS, with special responsibility for the Fluids Laboratory.
(*b*) SENIOR LECTURER IN THERMODYNAMICS
(*c*) ASSISTANT GRADE B.

Candidates for posts (*a*) and (*b*) should have an honours degree and professional qualifications with teaching and industrial experience. Ability to offer specialist subjects at postgraduate level would be an advantage. Post (*c*) involves the teaching of Applied Mechanics and associated subjects to the first and second years of the Diploma in Technology courses. Opportunities will be given for further study and research, and continued contact with industry is encouraged.

The Department is concerned mainly with courses leading to the Diploma in Technology and Higher National Certificate and postgraduate short courses. These activities will be widened when the Department's new buildings are completed.

Salary for posts (*a*) and (*b*) is in the range £1588-£1801 and for post (*c*) £828-£1486, at a point depending on qualifications and experience.

Further details and forms of applications may be obtained from the PRINCIPAL, DR. J. TOPPING, M.Sc., to whom completed forms should be returned within FOURTEEN DAYS.

C. E. GURR, M.Sc., Ph.D.
Chief Education Officer
D 570

UNIVERSITY OF LONDON
CHADWICK CHAIR OF CIVIL ENGINEERING AT UNIVERSITY COLLEGE

The Senate invite applications for the CHADWICK CHAIR OF CIVIL ENGINEERING tenable at University College (salary not less than £2600 a year plus £100 London Allowance). The holder of the Chair is the Head of the Department of Civil and Municipal Engineering. Applications (10 copies) must be received not later than 9 JANUARY, 1961, by the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1, from whom further particulars may be obtained. D 582

UNIVERSITY COLLEGE OF SWANSEA
CHAIR OF CIVIL ENGINEERING

Applications are invited for appointment to the CHAIR OF CIVIL ENGINEERING which will become vacant on MARCH 31 next.

Particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications must be sent by JANUARY 14, 1961. D 499

UNIVERSITY OF SYDNEY

Applications are invited for an ASSOCIATE PROFESSORSHIP, LECTURESHIPS/SENIOR LECTURESHIPS (2) and LECTURESHIPS (2) in MECHANICAL ENGINEERING, from graduates in Science or Engineering with strong research interests in any of the following: Analytical Methods in Applied Mechanics; Kinematics and Theory of Machines; Thermodynamics; Combustion; Fluid Mechanics; Control and Information Theory; Turbines and Rocket Propulsion; Elasticity and other branches of Engineering Science. The available facilities include access to the High Speed Computer SILLIAC.

Applications close with the REGISTRAR, UNIVERSITY OF SYDNEY, SYDNEY, AUSTRALIA, on 31st JANUARY, 1961.

For further information write to the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1. D 585

SOUTH EAST METROPOLITAN REGIONAL HOSPITAL BOARD

Applications invited for the post of:
PRINCIPAL ASSISTANT ENGINEER II in the Regional Engineer's Department. Salary, £1715-£2085. Candidates should possess Corporate Membership of the Institution of Mechanical Engineers or Associateship in Heating and Ventilating of the National College of Heating and Ventilating and have had not less than 2 years in the workshop of a reputable firm of general manufacturing engineers and 1 year on erection, or equivalent qualification.

Applications, stating age, qualifications, experience and present salary with names of three referees should reach the SECRETARY, 40, EASTBOURNE TERRACE, W.2, by 9th JANUARY, 1961. D 561

BRITISH BROADCASTING CORPORATION

Applications are invited from British subjects for the following permanent and pensionable London-based post in the

BUILDING DEPARTMENT

A Chartered Civil Engineer is required to assist in the administration and organisation of a variety of civil engineering and building works, including masts and towers. Executive and administrative experience of important works is essential. Salary in scale £1545 to £1970 p.a. commensurate with qualifications and experience. An exceptionally well experienced candidate will be considered for appointment into a grade with a maximum salary of £2180 p.a.

Requests for application forms should be addressed to

Engineering Recruitment Officer,
British Broadcasting Corporation,
Broadcasting House, London, W.1,

quoting ref. 60.E.172.Eng.

D 579

THE MOND NICKEL COMPANY LIMITED

requires

for development work in the ferrous field

STEELMAKER-METALLURGIST

with full practical melting-shop experience in the production of alloy steels, preferably including the austenitic stainless types. University degree or equivalent advantageous. The successful candidate will be located in London, but his duties will include foreign travel. Pension and assurance schemes are in operation and, in appropriate cases, assistance can be given for housing.

Applications, which will be treated in confidence, should give details of age, qualifications, experience, salary required, etc. They should be addressed to

THE GENERAL MANAGER,
DEVELOPMENT AND RESEARCH DEPT.,
THE MOND NICKEL COMPANY LTD.,
THAMES HOUSE, MILLBANK,
LONDON, S.W.1.

Please mark envelope 'Confidential D.33.'

D 563

ROLLS-ROYCE

AERO ENGINE DIVISION

Vacancies exist within the Derby Group of Factories for **QUALITY ENGINEERS** *and*

INSPECTION METHODS ENGINEERS

The prime requisite of QUALITY ENGINEER candidates is an inquiring and analytical mind. Statistical knowledge is not necessary provided there is an interest in product and process variability. For this appointment possession of a degree or H.N.C. in engineering is required.

Candidates interested in the INSPECTION METHODS ENGINEER appointments should possess a H.N.C. or O.N.C. with adequate past experience in any branch of production engineering.

Both posts offer exceptional opportunities for original work and the use of initiative with intelligence in a rapidly developing field of production management to those who have had at least two years' practical works training in mechanical engineering manufacture.

Applicants should quote preference for vacancy and should write to:—

STAFF MANAGER, AERO ENGINE DIVISION, ROLLS-ROYCE LIMITED,
P.O. BOX 31, DERBY

D 574

SUNDERLAND EDUCATION AUTHORITY

TECHNICAL COLLEGE

Applications are invited for the post of SENIOR LECTURER FOR RESEARCH IN MECHANICAL ENGINEERING. Candidates must have a good Honours degree, together with suitable experience in industry and in research.

Salary in accordance with the Burnham Technical Scale, viz., £1550 by £50 to £1750.

Further particulars from the Registrar, Technical College, Sunderland, Co. Durham. Applications should be returned to the undersigned within fourteen days. Canvassing disqualifies.

W. THOMPSON,
DIRECTOR OF EDUCATION.

EDUCATION OFFICES,
15, JOHN STREET,
SUNDERLAND
CO. DURHAM. D 577

MIDDLESEX COUNTY COUNCIL

EDUCATION COMMITTEE

ENFIELD TECHNICAL COLLEGE

QUEENSWAY, ENFIELD, MIDDLESEX

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Required as soon as possible:—

SENIOR LECTURER IN MECHANICAL ENGINEERING to teach Mechanics of Fluids to B.Sc. (Engineering) Degree standard and to take charge of the subject in the Department.

Candidates must be University Graduates in Engineering, be Corporate Members of the Institution of Mechanical Engineers or the Institution of Civil Engineering and have had teaching and industrial experience.

Salary within the range: £1588-£1801 per annum.

Application forms (foolscap s.a.e.) from the PRINCIPAL, R. McCRAE, B.Sc. (ENG.), to whom completed forms should be returned within 14 days of the appearance of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
CHIEF EDUCATION OFFICER.
D 587

LANCASHIRE COUNTY COUNCIL

Applications are invited for the post of:—
SUPERVISORY CLERK OF WORKS FOR THE THELWALL BRIDGE—a high level viaduct with a steel superstructure carrying the Birmingham-Preston Motorway over the Manchester Ship Canal near Warrington.

Applicants should have had extensive experience with a structural engineering firm as foreman or in an equivalent supervisory capacity in charge of the fabrication and erection of heavy bridge works.

Rate of pay—£940 by 4/£30 by 1/£35 to £1095, plus 35s. per week lodging allowance, commencing salary according to experience.

The duration of the work is 18 months, AND THE POST CARRIES A PROSPECT OF A PERMANENCY.

The appointment is subject to the successful applicant being passed medically fit.

Applications quoting reference 109/16 should be submitted by 24th DECEMBER, 1960, on a form obtainable from JAMES DRAKE, B.Sc., M.I.C.E., M.I.Mun.E., F.Inst.H.E., COUNTY SURVEYOR AND BRIDGEMASTER, P.O. BOX NO. 9, COUNTY HALL, PRESTON. D 572

UNIVERSITY OF SOUTHAMPTON

WESTLAND READERSHIP IN HELICOPTER ENGINEERING

Applications are invited for this newly established Readership in the Department of Aeronautics and Astronautics. Applicants should be suitably qualified with considerable experience in either helicopter design or vibration theory and the person appointed will be expected to engage in and direct research into some aspect of helicopter or rotary wing science.

Salary scale, £1650 by £75 to £2400 by £25 to £2425. F.S.S.U. and child allowance. Further particulars may be obtained from the SECRETARY AND REGISTRAR, THE UNIVERSITY, SOUTHAMPTON, to whom applications (14 copies from U.K. applicants) should be sent before 31st JANUARY, 1961. D 567

MERSEY DOCKS AND HARBOUR BOARD

ASSISTANT ENGINEER-IN-CHIEF

Applications are invited for appointment to the above post at an initial salary up to £3000 per annum, depending on qualifications and experience. Candidates must be fully trained and qualified Civil Engineers with wide experience in the design and execution of port works and at present hold a senior position with a Port Authority or Contractor.

There is a prospect of early promotion to the post of Principal Assistant and candidates must therefore possess good executive and administrative ability as well as high technical qualifications.

After a satisfactory probationary period the person appointed would be subject to the Board's Conditions of Service.

Applications should be received by the undersigned not later than the 30th JANUARY, 1961, and be marked "ASSISTANT ENGINEER-IN-CHIEF."

A. S. MOUNTFIELD,
GENERAL MANAGER AND SECRETARY.

DOCK OFFICE,
LIVERPOOL, 3. D 591

MINISTRY OF AVIATION

MINISTRY OF AVIATION require ASSISTANT TECHNICAL COSTS OFFICERS in Central London and Mottingham, S.E.9, for preparation of detailed prime cost estimates of the manufacture of engineering products. Duties will entail travelling. QUALIFICATIONS: Recognised engineering apprenticeship, O.N.C., C. & G. Final Certificates, or equivalent. Good engineering production and machine shop experience. Some experience in ratefixing, planning and estimating an advantage. SALARY: £875 (age 28)-£975. Good prospects of promotion and pension. Technical College courses sponsored for suitable candidates. Application forms from Manager (PE.3766), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. D 573

PORT OF BRISTOL AUTHORITY

Vacancy exists in Engineer-in-Chief's Department, Avonmouth Docks, for

AN ASSISTANT ENGINEER

(MECHANICAL)

Salary Grade APT.V.—£1310-£1480 p.a.

Candidates should have served an approved apprenticeship and have had design experience. They should be Corporate Members of a recognised Engineering Institution, or eligible for Corporate Membership within two years.

Duties will include repair and maintenance of grain handling machinery, cranes, locomotives, pumps. etc., and preparation of specifications, estimates, etc., for new work.

Commencing salary within range quoted will depend upon experience. Post pensionable; medical examination and probationary period of six months.

Applicants must disclose whether they are related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications, stating age, qualifications, experience, etc., and enclosing, if possible, copies of recent testimonials, to ENGINEER-IN-CHIEF, PORT OF BRISTOL AUTHORITY, AVONMOUTH DOCKS, BRISTOL, by TEN A.M., 31st DECEMBER. D 599

MANCHESTER CORPORATION

WATERWORKS UNDERTAKING

Applications are invited for the appointment of DEPUTY ENGINEER AND MANAGER of the MANCHESTER CORPORATION WATERWORKS UNDERTAKING. Applicants should be Civil Engineers with administrative experience, preferably having a wide experience of the design and construction of large civil engineering works for water supply.

Commencing salary, £3095 per annum, rising by annual increments of £100 to £3395 per annum.

Details of appointment and application forms (returnable by 31st DECEMBER, 1960) from the SECRETARY, WATERWORKS DEPARTMENT, TOWN HALL, MANCHESTER 2. D 598

LONDON COUNTY COUNCIL

POPLAR TECHNICAL COLLEGE

SECONDARY TECHNICAL BOYS' SCHOOL

HIGH STREET, E.14

(280 pupils, age range 11 to 16)

QUALIFIED MASTER required for MECHANICS (GRADED POST, ALLOWANCE £90). Burnham P. and S. salary scale, £520 by £27 10s. to £1000, plus London allowance, £38 or £51; additions for qualifications and training; increments within scale for experience.

Application forms from SECRETARY to be returned by 6th JANUARY, 1961, quoting (FE.3a/E/3117/12). D 595

UNIVERSITY OF SOUTHAMPTON

Vacancies occur in the DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS for RESEARCH FELLOWSHIPS and ASSISTANTSHIPS in the following programmes of research:

(*a*) Turbulence in Jets and its relation to noise.
(*b*) The effect of noise on structures.
(*c*) Cumulative fatigue damage of structures.

Applicants should have a good honours degree in Engineering, Physics, Mathematics or Metallurgy, or its equivalent, experience in vibration or noise analysis being an advantage but not essential. Successful applicants for research assistantships are expected to register for a higher degree. Research fellowships are normally awarded to applicants with higher degrees or equivalent experience. Salaries are in accordance with qualifications and experience. Applications (4 copies) giving name, age, details of qualifications and experience, together with the names of two referees should be sent to the SECRETARY AND REGISTRAR, THE UNIVERSITY, SOUTHAMPTON before 31st JANUARY, 1961. D 566

APPOINTMENTS OPEN

DRAUGHTSMEN

DRAUGHTSMEN are required by Vickers-Armstrongs (Engineers) Ltd., for their Southampton Drawing Office. Applicants should have served a recognised apprenticeship and had experience in Marine or General Engineering. Pleasant conditions are offered in a modern well-equipped office. Salary in accordance with age, experience and qualifications. Please write to THE MANAGER, VICKERS-ARMSTRONGS (ENGINEERS) LTD., OAK YARD, HAZEL ROAD, ITCHEN, SOUTHAMPTON. D 584

ASSISTANT CHIEF ENGINEER

ASSISTANT CHIEF ENGINEER required for Engineering Office on North East Coast. The work of the Company is connected with the design and construction of industrial power stations and general mechanical/electrification work and demands a knowledgeable and keen man between 35 and 45 years of age. The applicant must be a graduate or chartered mechanical/electrical engineer used to leadership and with a good experience in Contract work. Ability to work harmoniously yet firmly with existing staff is essential.

Contributory Superannuation Scheme in operation.

Reply giving full details of present salary and previous experience to BOX D 547, Offices of ENGINEERING.

PLANT INSPECTORS

BRITISH PETROLEUM COMPANY LIMITED have vacancies for PLANT INSPECTORS for service in the U.K. and overseas. Applicants, aged under 35, must hold 1st Class M.O.T. (Steam) Certificate, and A.M.I.Mech.E. or H.N.C. is desirable. Full apprenticeship, preferably with firm manufacturing boilers and/or pressure vessels, followed by several years' practical experience in the operation and maintenance of steam boilers and/or pressure vessels. Previous experience of inspection methods as applied to above type of equipment advantageous. Salary according to age, qualifications and experience. Non-contributory Pension Fund. Housing Scheme. Removal expenses and settling-in allowance payable in certain cases. Luncheon Club.—Write, giving full details, quoting reference H.5376, to BOX 6469, c/o HANWAY HOUSE, CLARK'S PLACE, E.C.2. D 576

PLANT ENGINEER/DRAUGHTSMAN

COMPETENT ENGINEER required to be responsible for layout, installation and maintenance of services including Oil Fired L.P. Heating, Electrical, Gas, Compressed Air and other ancillaries in S.W. England Light Engineering Factory employing 500. House available. Applications giving full particulars of age, training, experience and salary, to BOX D 578, Offices of ENGINEERING.

AGENTS AND REPRESENTATIVES

AGENTS AND REPRESENTATIVES REQUIRED, GOOD CONNECTIONS. WRITE: STEEL WOOL FACTORY (LONDON) LIMITED, SILVERDALE ROAD, HAYES, MIDDLESEX. D 568

INSPECTOR

INSPECTOR required. Must be fully conversant with all forms of inspection. Range of inspection to cover machine shop production, parts produced from various jigs and fixtures and some small welded fabrication. Salary depends on age and experience. Please apply to BOX D 588, Offices of ENGINEERING.

MECHANICAL ENGINEER

MECHANICAL ENGINEER, H.N.C. STANDARD required for non-destructive testing of materials and vessels. Specialised training will be given to successful candidate. Progressive salary with non-contributory pension.—BOX D 583, Offices of ENGINEERING.

MECHANICAL ENGINEER

MAY & BAKER LTD., DAGENHAM, ESSEX, seek a Mechanical Engineer (preferably within the age range 25-30 years) to specialise in the Design and Layout of Plant for the Manufacture and Packaging of Pharmaceutical Products. Candidates with good engineering qualifications and some previous experience in this field preferred. There is a Life Assurance and Pension Scheme in operation.—Apply in writing with full details to the PERSONNEL OFFICER quoting REFERENCE NO. 208/60.

D 597

CHEMICAL ENGINEERING DRAUGHTSMAN

£1000 per annum post is vacant in very pleasantly situated large factory in the North West, near to the sea. The post is permanent and pensionable. Minimum requirements, H.N.C. and good background experience in chemical or allied industries.—Apply BOX D 596, Offices of ENGINEERING.

CHARTERED ELECTRICAL ENGINEER

A vacancy exists for a chartered electrical engineer with an Hydro-Electric Power undertaking in Northern Nigeria. Pleasant climate, 4000 ft. above sea level. Age 30 to 35. Salary grade £1335/£1565 according to age, qualification and experience. Pension and Life Assurance Scheme. Eighteen months tours with three months' leave on full salary. Free furnished quarters. Free passages self, wife and two children, or equivalent benefits if children remain at home.—Write BOX E.996, c/o STREET'S, 110 OLD BROAD STREET, E.C.2. D 594

SENIOR PLANNING ENGINEER

SENIOR PLANNING ENGINEER required, (must have good all round experience in Heavy Engineering and Works Study. Write giving age, experience and other particulars to Personnel Manager, BOX D 592, Offices of ENGINEERING.

Another Opportunity in Iron & Steel

BISRA

AUTOMATION RESEARCH

The Steel Industry is a highly progressive basic industry which offers great scope for application of automation. Research work on this subject is conducted at the BISRA London Laboratories by groups working on Operational Research, Complex Control System Design, Control Engineering, and Instrument Research. There are vacancies for staff in several of these rapidly developing groups which offer young men opportunities to do very interesting basic and applied research and to advance themselves professionally by publication of work and participation in the activities of Learned Societies. Applications are invited from candidates with a good degree in Science, Engineering or Mathematics and some experience in research on Instrumentation, Control Engineering Information, Handling Technology, or Complex System Control. Vacancies exist for staff in the commencing salary ranges up to £1500 per annum. Posts are superannuated under the F.S.S.U.

Written applications only quoting 'P.E.C.1,' to the Personnel Officer, The British Iron and Steel Research Association, 11, Park Lane, London, W.1. D 564

HEAD OF CONTROL ENGINEERING SECTION

A leading Industrial Research Organisation has a vacancy for a Senior Control Engineer to lead a team engaged on the application of advanced control engineering to a highly progressive industry. The post will interest men in their early to middle 30's already earning between £1500 and £1700 who are looking for a substantial increase in salary and good prospects for advancement.

Candidates we would like to hear from are those with a good Hons. Degree in Engineering or Physics, some years' experience in Automation Research, an enthusiasm for stimulating and progressing the application of advanced control engineering techniques in industry, and a definite ability to lead.

Applications in strict confidence to BOX D 565, Offices of ENGINEERING.

Millars'

MACHINERY CO. LIMITED

CHIEF DRAUGHTSMAN

Applications are invited for this appointment to control a medium sized Drawing Office of a well-established Engineering Company. Manufacturers of Building and Civil Engineering Plant. His responsibilities will include administration, technical supervision and drawing office standards and procedure. A knowledge of Plant Work or Mechanical Handling is preferable, a good general mechanical experience is essential. This position offers excellent opportunity to an enthusiastic man with suitable experience. A pension fund and life assurance scheme is in operation. Write in confidence giving details to:

Personnel Manager

MILLARS' MACHINERY CO. LIMITED
THORLEY WORKS,
BISHOP'S STORTFORD, HERTS.

D 593

SMITHS

Development Engineer for CAMERA PRODUCTS

A Senior Engineer is required to concentrate on the design and development of electronic, mechanical and photo-electric devices in automatic cameras. Applicants should be experienced in fine instrument work of an electro-mechanical nature and qualified to B.Sc. standard. Age 25-40 years. Lesser qualifications may be acceptable if backed by extensive experience. A knowledge of camera design and photography would be advantageous but not essential. This is a senior position and carries commensurate salary and conditions.

★ Applications will be treated in strict confidence
★ Interviews arranged to suit your convenience
★ Write in confidence, or telephone for further information quoting reference SM.344/E, to:

The Staff Manager,
S. Smith & Sons (England) Ltd.,
Cricklewood,
London, N.W.2
Telephone: GLAdstone 3333 (Ext 132)

D 586

Opportunities for GRADUATE ENGINEERS & PIPING DESIGNERS

as a result of increasing expansion

Our record of expansion over the past years necessitates the engagement of additional engineers and designers for the Design Office to undertake Petroleum Refinery and Petrochemical projects.

GRADUATE ENGINEERS

(CHEMICAL & MECHANICAL ENGINEERING)

Applicants will be considered up to the age of 33 years and should preferably be currently engaged in design, operating, or other technical phases of refinery, chemical plants or other similar installations such as power plants, gas works, etc.

These appointments offer interesting work in engineering design with attractive future prospects and are available to highest calibre men with post-graduate experience who are seeking to broaden their experience and prospects for advancement.

Starting salaries will be up to £1800 depending upon the age and experience of the candidate.

PIPING DESIGNERS

Immediate vacancies exist for Piping Designers with 5 years' or more experience in the layout and design of piping for refinery and chemical plants or in related industries. We have an established reputation in the field of piping systems and their design, and therefore persons joining the Corporation will have a unique opportunity for broadening their own knowledge.

Salaries payable will be £1100 to £1500 according to qualifications and experience.

All these positions are permanent and offer well-paid careers with good prospects of promotion and salary advancement. Comprehensive personnel benefits, including contributory pension scheme, excellent working conditions, Luncheon Vouchers, free life insurance benefits and generous overtime payments, etc. Five-day week. Extra holidays for length of service. Assistance with removal expenses may be given to those engaged from outside Greater London.

Please write to Mr. R. H. Paterson

KELLOGG INTERNATIONAL CORPORATION
7-10 CHANDOS STREET LONDON W1
Tel: MUS 4010 Please quote reference 172/H.

D 562

VICKERS-ARMSTRONGS (ENGINEERS) LTD.

Applications are invited for the following positions in the Nuclear Power Division which is responsible for the installation of Propulsion Machinery in Nuclear Submarines.

Technicians

for thermodynamics, heat balance and general stress work. Candidates should have a Degree or good H.N.C.

Draughtsmen

for machinery and pipe system arrangement work. Candidates should have O.N.C. or M.O.T. Certificate as minimum qualification and drawing office experience on Marine work is desirable.

Development Engineers

for work in connection with investigating improved methods of design for production and installation. Candidates should have H.N.C. as minimum qualification and appropriate experience.

These positions offer scope for advancement in a new and expanding department.

Successful applicants will be required to join the Company's Contributory Superannuation Scheme when eligible.

Applications, which will be treated in strictest confidence, should give full details of age, qualifications and experience and current salary and be addressed to:—

The Manager, Nuclear Power Division, VICKERS-ARMSTRONGS (Engineers) LTD
Naval Construction Works, Barrow-in-Furness, Lancashire.

D 590

Required by large manufacturing company a:

PURCHASING OFFICER

(Age group 27/30 years)

This is a new appointment within a developing department. The successful applicant will be responsible for purchasing all engineering material and equipment, and will be located in London. *Consideration will only be given to qualified engineers with sound commercial experience.*

Applications giving fullest details should be addressed to:— BOX No. DL 6861 c/o Whites, 72 Fleet Street, London, E.C.4

D 580

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent, on 52.

BOX NUMBER: 2s.
COPY DATE: First post Monday.
BLOCKS: To be mounted ready for printing. Screen 100.
ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Company Meetings

COPY DATE: First post Monday.
BLOCKS: To be mounted ready for printing. Screen 100.
ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

COMPANY MEETING

SAMUEL OSBORN & CO., LTD.

RECORD SALES AND PROFITS

Mr. Frank A. Hurst on Promotion of Export Trade

The 55th annual general meeting of Samuel Osborn & Co., Limited, was held on December 12 at Sheffield.

Mr. Frank A. Hurst (Chairman and Managing Director) presided and, in the course of his speech, said:

The Accounts refer to the year ended 31st July, 1960 and, in contrast to those of last year, they cover a year when the great majority of the companies of our Group were working to capacity, and that really means, as far as the labour force at their disposal would allow; this has resulted in the highest sales figure in our history and with a record profit.

The Manufacturing and Trading Profit for the year under review amounted to £1,533,052 and this is forty per cent above that of the previous year. The result clearly indicates that despite severe competition in both the home and overseas markets our manufacturing efficiency has been improved.

In the coming year we shall complete several new development projects and the new plant involved in these should increase our output and, I hope, maintain our position.

EXPORT TRADE

I regret I am not able to report that the direct exports of our United Kingdom companies have increased substantially. Unfair criticism by members of the Government and others, all of whom should know better, has been made suggesting that managements of manufacturing companies and their sales executives neglect export trading and have lack of vision. You will be interested to know that during the year Directors or senior executives of this Company have visited the following countries: Australia, Canada, India, Kenya, New Zealand, Pakistan, Northern and Southern Rhodesia, Singapore, South Africa, Israel, U.S.A., Austria, Belgium, France, Germany, Holland, Switzerland, Denmark, Norway, Sweden, and we have been very pleased to have visits from Directors and senior executives of a large number of our overseas subsidiaries, agents and customers. I am sure you will agree that we cannot be charged with neglecting exports.

On the other hand, there is a different aspect to this matter on which those to whom I referred earlier failed to comment; they preferred to generalize. I agree that we, as a country, must export, but surely what we want to export mainly is the product which has the highest conversion value; that is to say, it is better for basic industry to supply its product to another industry within this country, and perhaps even a third, to enable us to export the end product the overseas customer will use rather than the component part a manufacturer in his country will buy to incorporate in the end product to be completed there. Our Company must, therefore, not neglect to give consideration to its customers at home, who, in many cases, are using our materials for exporting goods of higher values of work content. Indeed, in past times of shortages, this has been the exhortation of the Government itself.

Inability to meet competition even at sacrifice is responsible, in many cases, for the difficulty in increasing exports. In a large measure this is due to the exceedingly heavy taxation in this Country and also to increasing costs. Taking this Group of Companies as an example, the net profit for the year before taxation amounted to £1,576,307 but the amount finally ploughed back for future development was £432,526, that is, 27½ per cent of the total, because of taxation £869,716 (55 per cent) and interests of outside shareholders and dividends £274,065 (17½ per cent).

NEED FOR CONTROL OF IMPORTS

In regard to climbing imports, as against the value of exports, I am conscious of the anxiety of those in authority, and in this respect I would remind those who are dismayed that for years I have advocated the implementation of the provisions of the Customs Duties (Dumping and Subsidies) Act 1957, but up to the present I have only suggested that the equivalent home market value of the goods be stated on invoices covering imports. Already I have knowledge of the intention to make large importations of steels of the types we and other Sheffield manufacturers produce into this Country in January next year, and these will be brought in at prices below the equivalent home market value of the goods in the country of origin. We do not fear fair competition but such importations as these will be detrimental to local producers of the types of steel in question and will also be to the disadvantage of full employment of workers in the industry.

STAFF AND PROSPECTS: We have had another year free from labour trouble and again I am happy to be able to express my pride in all the employees of every grade. They have shown a wonderful team spirit which has made our satisfactory financial result possible. I am glad to report that prospects are good and that we have an order book which will ensure full employment for some time ahead.

The report and accounts were adopted.

D 589

Companies

Well Found Confidence in Bearing Firm

THE RANSOME AND MARLES BEARING Company are able to state in their annual report that the capital expenditure on plant in the past year not only increased production but also efficiency, and made it possible to absorb the extra cost of cutting the working week from 44 to 42 hours.

Both turnover and profit from the overseas subsidiaries have risen and the company's total export volume has also increased.

In the previous year Ransomes, with SKF, Gothenburg, and Skefko, Luton, made a successful bid for the Australian Government's bearing factory at Echuca. An Australian company, UNITED BEARING CORPORATION Pty, has now been formed and development of its manufacturing capacity is now taking place.

The Ransome order book has now been static for about three months but it increased steadily throughout the financial year reviewed and has reached a level described by Mr. Edward Senior, the chairman, as "very satisfactory." Sales are at a higher level than at this time last year.

It is not expected that the company can altogether escape the effects of the reduced demand for consumer durables brought on by the credit squeeze. On the other side of the argument much of the present position is seasonal and demand remains boyant in the capital goods sector.

The net trading surplus for the year was £1,182,056, against £1,711,232 the year before. With the considerable expansion in productive capacity which is scheduled for the company, the capital commitment figure in the balance sheet is mainly for such further development. Permission has been sought, and obtained, to increase the capital of the company. The capital is to be increased from £2 million to £4 million by the creation of 8 million additional 5*s* shares. Approval was also given at an extraordinary general meeting following the annual meeting, for the capitalisation of £1 million from the reserves in order to make a scrip issue of one new share for every two held.

Aerosol Prosperity and Nigerian Expansion

Four years of increasing competition and rising costs have not prevented MIDLAND ALUMINIUM Limited from returning increased profits each year, culminating in a profit before taxation for 1960 of £248,442, compared with £219,103 in 1959.

Major C. R. Dibben, the chairman, saw no indication, at the time of his annual report, that the industrial and economic pause in the hitherto upward trend amounted to anything approaching a major recession.

With the trading results for the first three months of the current year available the company expects, given favourable trading conditions, that the steady progress in output and in profits will be well maintained.

The big point in the past year for Midland Aluminium has been its Nigerian project. The factory began production last August and now the rate of output and the quality of product is regarded as satisfactory at this stage.

Sale of aerosols in Britain went on at record levels last year. The production from MIDLAND AEROSOLS Limited for this year will be the highest since the company was started.

Beagle Air Group Acquire Miles Aviation

The thirty year old light aircraft and military trainer company, F. G. MILES, of Shoreham Airport, Sussex, have been acquired by the new PRESSED STEEL light aircraft company, BRITISH EXECUTIVE AND GENERAL AVIATION Limited (BEAGLE).

The Miles executive directors will continue in their positions. The Beagle chairman, Mr. Peter Masefield, will become chairman of Miles. Mr. F. G. Miles will be deputy chairman.

The new arrangement is described as a logical development of the manufacturing and technical liaison which has been maintained between Miles and Beagle since the announcement of the new group. Beagle already has one subsidiary company—AUSTER AIRCRAFT Limited.

The aim of Beagle is to produce executive and light aircraft for the home market and for export.

From Fire Engines to Standard Vanguards

There is at least one highly significant link between the LEYLAND MOTORS and STANDARD - TRIUMPH INTERNATIONAL companies whose merger moves, if successful, will materially change the balance of power between the big British vehicle firms.

The unending list of export successes achieved by Leyland coach and lorry chassis is explained only by continuous technical advance, backed by a vigourous sales policy. Among the more recent new models from the car firms the Standard-Triumph Herald has a recognised place for its improvements, particularly in relation to servicing and repairs.

Two such teams of engineers should run well together in harness. A certain advantage to Leyland will also lie in the possibility the link-up will give them of introducing the diesel engine more widely into light commercial vehicles. In addition to their range of cars, including the Herald and the Standard Vanguard, and their own diesel engines and gas-turbines, the Standard company manufacture commercial vehicles up to one ton.

This means a Leyland-Triumph group would be offering a comprehensive range from the heavyweights of the Lancashire company and their Glasgow division, ALBION MOTORS, complete with fire engines and trolley buses through to the Standard lighter commercial vehicles.

The difficulties brought on by the current motor industry recession had brought on a crop of merger rumours in connection with Standard-Triumph. These had stretched out to include Chrysler and it was known that ROOTES had held some talks but without making a formal offer. Sir Henry Spurrier, the Leyland chairman has made his moves almost unguessed at.

Taking a long term view it is possible to speculate whether the merger may not eventually lead to greater efforts for the development of a popularly priced diesel engined car, for Great Britain and the overseas markets.

Long Term View from Tedder at Standard-Triumph

That STANDARD-TRIUMPH INTERNATIONAL should have produced 139,032 cars in the first complete year of operations following the sale of the tractor division to MASSEY-FERGUSON is a sure indication of the speed with which the company achieved its objective of making good the loss of turnover due to having off the tractors.

In the last year of the company as a combined car and tractor concern the output was 89,145 cars and 69,711 tractors.

It is particularly bad luck for Standard-Triumph that so soon after the introduction of their advanced model, the Herald, and with developments in the Stanguard Vanguard, the home car market and the United States market should have contracted with a speed that has thrown the industry generally on to short time.

Looking to the car industry's future, Lord Tedder, the STI chairman (inset) who is to become its president and be succeeded as chairman by managing director Alick Dick, according to an earlier announcement, sets out three conditions that must be observed if the United Kingdom's car manufacturers are to have a fair chance to sell overseas. They are:

A stable and profitable home base,

Resolution of the political problems preventing Britain from entering the European Common Market,

Establishment of a political atmosphere between the Great Powers to ensure the progressive development of international trade.

Rapid development is being carried out in the STI industrial engine division which is meeting a growing interest in both its diesel and petrol engines.

An All-Embracing Industrial Group

Spread throughout general engineering, scrap, machine tool production, cement and quarrying, iron, steel and non-ferrous metals, vehicles and asbestos and refrigeration, the THOMAS W. WARD concern provides in itself something of a window on United Kingdom industry.

The group turnover in the past financial year increased by £6 million to £49¼ million, a record and almost a million above than the previous best of 1957.

Certain special temporary influences made 1959 a non-typical year for the group and 1958 is regarded as a better basis for comparison. The ratio of profit to turnover in 1958 was 5·34 per cent and in the last financial year 5·69 per cent.

The engineering subsidiary companies in the financial year 1960 showed small decreases in turnover but sharp falls in profits. All the other main groups, iron and steel, cement and quarrying, distribution and repair of motor vehicles all showed profit increases proportionate to their rising turnover.

The parent company, the scrap side of the group, had a turnover improvement of £3 million due to increased activity in its iron and steel sections and ship breaking. Sales tonnage was up by about 15 per cent on 1958, an improvement in line with the increase in national steel output.

Although an unlimited demand existed for scrap for steel furnaces, blast furnaces and steel foundries, the demand for cast iron scrap was slack in the first half of the year, picking up in the later months. All this heightened activity is accompanied by falling profit margins and it is anticipated that the margins may fall more during the coming year.

One of the subsidiaries which best illustrates the complex position in engineering is THOMAS SMITH AND SONS (RODLEY) Limited, manufacturers of excavators and cranes. Demand for excavators has been such that longer delivery periods have been unavoidable. But there is room for improvement in the crane demand. Another crane company, JOHN SMITH (KEIGHLEY) have kept turnover up to about the 1959 level but intensifying competition and declining profit margins have reduced the profits. Holding a good order book, this company has difficulty in finding all the labour it could use. Negotiations are going on for the part production of Smith cranes in India.

Surveying the future prospects for the group's engineering interests Mr. W. H. Secker, the Ward chairman, declared in his review that he sees the highly competitive conditions continuing and no sign of relief in the difficulties of obtaining an adequate labour force.

Better Times for Tractor Makers

Full time working at MASSEY-FERGUSON'S Banner Lane, Coventry, tractor factory has now been resumed after two months of limited short time.

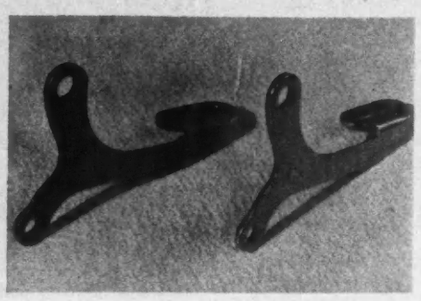
Rising exports seemed to have accounted for the recovery rather than any strong upturn in the depressed home demand for tractors. In the first ten months of 1960 exports of UK-produced farm machinery amounted to £108·7 million, £3 million more than the figure for the whole of the previous year.

In all 1959, UK tractor exports reached a total of 115,769. By the end of October the number of tractors exported from Britain was 123,663. Exports to Australia rose by 40 per cent in the first ten months of the year and shipments to the United States by slightly more.

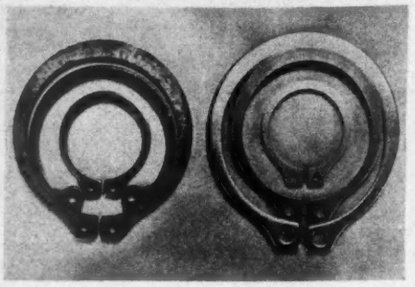
Finland, South Africa and Brazil were the three other main markets.

Cleaning Off Components More Quickly

The vibration of castings, forgings and stampings in a mass of chips and compound has advantages over the precision barrelling process. Not least of the advantages is the shorter process time.



A bicycle part before and after processing in the vibrator.



Circlips can be deburred by a vibrator in half an hour.

THE precision barrelling process has firmly established itself over the years in engineering industries as a process for finishing components. In recent years, rapid strides have been made in the development of the process which involves the rotation of components together with an appropriate medium in an octagonal barrel. This medium might be stone chippings, wooden cubes or another specially prepared chip product which serves two main purposes. The first of these is to act as a carrier for an abrasive or polishing compound and the second is to separate the components being barrelled so that they do not damage each other. In the main, barrelling is used on metal parts.

In spite of the considerable success of this barrelling method in its various applications such as deburring, surface smoothing, descaling and polishing, it has a number of disadvantages. However carefully barrelling is done, there is always a certain amount of sliding or tumbling action along the surface of the rotating mass of chips and parts. This cascading movement tends to give rise to peening at the ends of the parts, to the entanglement of complex parts, and to distortion and damage to delicate parts or parts made of the softer metals, such as zinc base die castings and heavy steel parts machined to a close tolerance.

The greatest criticism levelled at precision barrelling, however, is its inefficiency. At any one time, the only parts receiving treatment are those on the cascading surface of the chip mass, the remainder being relatively static. This means that during the normal barrelling process, only about one-tenth of the parts in the barrel will be found to be receiving treatment at any given moment.

These disadvantages have stimulated a long period of development work by Carl Kurt Walther GmbH of Wuppertal, Germany. The result of this work is the Trowal-Vibrator which is now being made in the UK and called the Lacromatic Vibrator.

Like the barrel, the vibrator processes parts in a mass of chips, compound and water; but instead of rotating the parts, it vibrates them at high speed. This is done in a U-section rubber lined steel trough coupled to a variable speed vibrator mechanism. The trough itself is mounted on springs which enable it to vibrate freely. Vibrations are induced by an out-of-balance shaft which produces what should more correctly be described as an elliptical movement rather than as a reciprocating vibration. The result of this is that the chips and parts not only act intensely against each other, but also rotate slowly in the trough as a complete mass.

The main advantage of the Lacromatic Vibrator process is its speed of operation, which is partly due to the fact that all the chips and all the parts are moving all the time and partly due to the fact that the relative movement between chip and part is produced mechanically and does not depend upon gravity during a cascading action.

In addition to this, some parts which cannot be processed in a barrel or which can only be processed in one with difficulty can be processed in a vibrator.

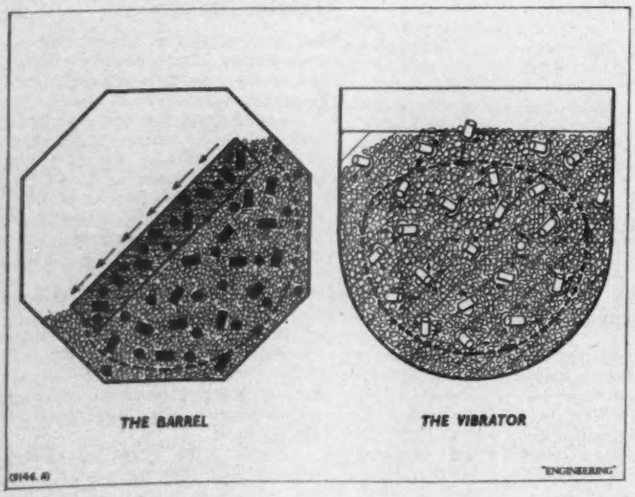
Sometimes a combination of these two virtues can result in remarkable time savings. This can be illustrated by two distinct cases. One of these is the processing of steel stampings which are components for bicycle brakes. These need to have their surfaces and edges completely smoothed. When this is done in a barrel, a very long abrasive run is needed because rapid processing is found to damage the parts. The damage is caused by contact between parts which does not happen at low speed. In the vibrator on the other hand, this tendency for pecking during the harsh abrasive run does not arise, and in consequence the abrasive run in the vibrator can be very much harsher. The result of this is that a grinding time of 30 hours in a barrel can be reduced to 3 hours in a vibrator.

A second instance where a combination of the two factors has produced great savings is in the deburring of small steel circlips. These occupy very little space and have very little burr to be removed. However, they inevitably interlock and entangle in a mass in a barrel—to such an extent that the process takes 8 hours. The same circlips have been processed in a vibrator in under 30 minutes.

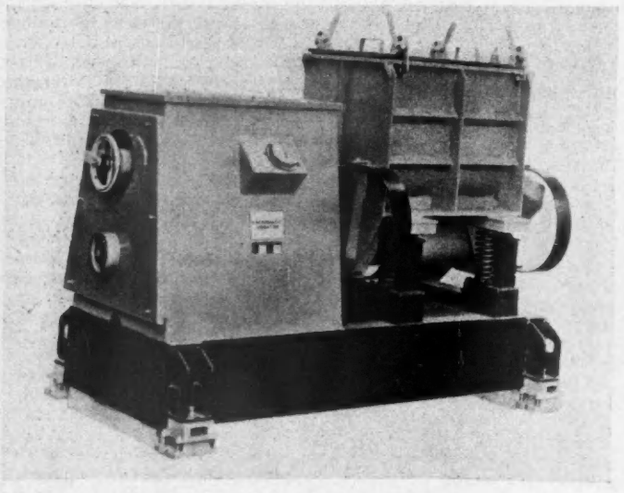
Normally, a concave surface is neglected by the ordinary precision barrelling process. For instance, a part shaped like a tea cup will go round in the barrel with a cupful of chips inside it. The internal surface will, therefore, be given little action, if any at all. When such a part is processed in a vibrator, however, the cupful of chips to which the vibrations are transmitted produces an effective grinding or polishing action depending upon the type of medium in use. This principle has been applied recently to phosphor bronze bearing cages from which the internal burrs have been removed in a matter of 15 minutes.

In the case of zinc base die castings which have to be deflashed, smoothed and burnished ready for plating, a typical processing time in the vibrator is 20 minutes of smoothing in chips with a mild abrasive compound and 20 minutes of burnishing in steel balls, likewise in the vibrator, with a burnishing compound. In contrast, when steel ball burnishing is done in a barrelling machine, the best results are obtained after 2 or 3 hours.

The actions of barrel and vibrator, in the former only parts in the shaded area are being treated.



The capacity of this particular version of the Lacromatic vibrator is 5½ cu. ft.



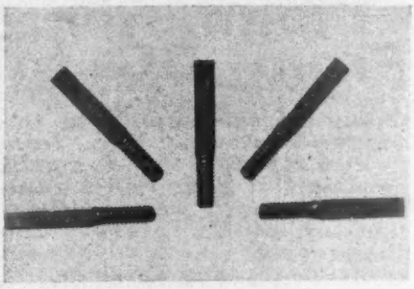
Threaded components can be deburred fairly quickly in a barrelling machine. The main drawback is that if the process is too rapid, the threads are damaged. The only answer is to use a gentle and lengthy process. One component of this type, a threaded screw insert, is shown in one of the accompanying illustrations. The vibrator has been used on these parts as an alternative process and the tendency for the edges to be radiused is then minimised. Inserts can be processed in 1 hour with a mildly abrasive compound and Lacron GP Chips No. 5 —namely of a size which will pass through a $\frac{1}{2}$ in square mesh screen but remain on top of a $\frac{1}{4}$ in square mesh screen.

Another case is the small mild steel pressing, an example of which is provided by a component of a small lock. For its size of approximately $\frac{1}{2}$ in by $\frac{1}{2}$ in, this part has very heavy burrs. These can of course be removed by conventional precision barrelling, but entail a considerable process time. On the other hand, this part was found to have been effectively deburred after it had been in the vibrator for 40 minutes with small chips and a coarse abrasive compound.

Though the vibrator overcomes a number of the basic disadvantages of precision barrelling, certain large or bulky parts must be mounted on a jig before they are inserted in the vibrator trough, just as they have to be mounted for precision barrelling. This has been found necessary, for example, in the case of camshafts.

The vibrator lends itself fairly readily to inclusion in a flow production line. It is available in a fully automatic form in which the chips and parts are fed together into the U-shaped trough by a conveyor belt. As one end of the trough is slightly lower than the other, the chips and parts gravitate to that end to leave the trough slowly before falling on to a vibrating screen which separates the chips from the parts and feeds the chips back to the loading conveyor belt.

The Lacromatic Vibrator is supplied with a control panel by which the vibrator can automatically switch itself on or off after a preset time interval. The control panel also has a reversing switch. This is used mainly when components are jigged in the vibrator trough and the direction of flow of the chip mass has to be changed to ensure even processing. The tachometer and hand wheel for varying speed are fitted to the housing of the motor and variable speed mechanism.



The threaded insert can be processed quickly and without damage.

Lacromatic Vibrators are made by the Hockley Chemical Company Limited of Birmingham who also sell the equipment in the United Kingdom.

Friction Welding in USA

In the first large scale laboratory study of friction welding to take place in America, a number of facts were uncovered which may lead to a practical application of the process in the USA.

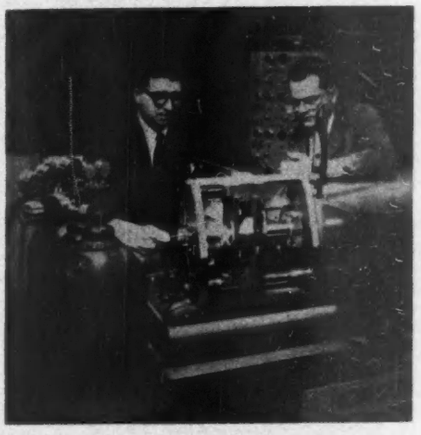
Most of the work on this process has been carried out in Russia, Poland and Czechoslavakia where production machines have been produced. Friction welding is a process for converting the mechanical energy of two metals, plastic or ceramic objects revolving or sliding in contact with one another into thermal energy, which under proper conditions and controls results in a weld of two (or more) objects in the contact area. An article on the subject appeared in ENGINEERING, 19 Aug. '60, p. 250.

Explanations of the process given so far may be summarised as follows: friction welding is a variant of pressure welding and the weld is made during plastic deformation of the abutting faces. The two objects revolve or oscillate against each other until the heat of friction produces the temperature required for pressure welding. At this point, motion is stopped and the two pieces are held together by pressure to form a weld. The Americans consider that this explanation is "pragmatic or instinctive."

The study carried out at the central research laboratory of the American Machine and Foundry Company of New York has lead to what appears to be a more refined explanation of the process. A study of the records of a highly instrumentated laboratory friction welding machine built by the company produced data about the weld phenomenon which, in the opinion of the research workers, is more revealing than the Russian reports. One of the elements of a theory proposed by the Americans is the postulation of a layer of fluid metal formed at the interface of the two objects particularly in the case of alloy steels. This layer acts as if it were a hydrodynamic thrust bearing or high pressure lubricant.

The laboratory also investigated, derived and measured the basic parameters and machine requirements for friction welding such as: speeds of rotation, machine rigidity, time and weld cycle sequence, torque, pressure, temperature, heat treatment, grain growth, metallurgy and weld geometry. Included in the investigation there was a study of the friction welding of a variety of materials including carbon, alloy and stainless steels, brass, aluminium, copper and zirconium.

The company now intends to continue its friction welding studies in order to refine and elaborate its theories.



The experimental friction welding machine during the welding of high carbon steel.

Conditions for Making Safety Glass

A recent contract completed by AEI-Birlec Limited of Birmingham involved the supply and installation of an air conditioning scheme at the King's Norton factory of the Triplex Safety Glass Company Limited. The plant was installed in order that the high quality bullet-proof glass panels made by Triplex for aircraft and similar purposes could be produced under ideal conditions. The aim of the installation is to increase output by reducing the proportion of rejects experienced by manufacturers of glass of this quality and type.

In the manufacture of the panels, incoming glass is optically tested before being cut to shape and assembled into a "sandwich" comprising between two and five layers of glass together with interlayers of transparent plastic. The assemblage is then subjected to heat and pressure and becomes an integral block. The glasses may then be toughened for extra strength, curved, or coated with a thin transparent film of gold. This gold film can be electrically heated to prevent the formation of ice on exposed surfaces.

It is essential that the room where the components of the glass panels are assembled should be airtight, and dust and moisture free in order to eliminate the possibility of defects developing in this expensive product. AEI-Birlec supplied this room, and also the supporting steel work erected above the roof of the room to carry the dehumidifier and the complete air conditioning plant.

Incorporated in the plant is a unique system of recirculating ducting and a Birlec COS type dehumidifier which delivers 1,500 cu. ft per min of dry air to the system. The plant removes air from the room through low level grilles and introduces 550 cu. ft per min of fresh air into the system. Air passing through the dehumidifier enters with a moisture content of 2·6 grains per cu. ft and leaves with 0·25 grains per cu. ft. After the dehumidifier, the air passes through a cooler and is maintained at 70° F. A second cooler brings the temperature down to 30° F. This cool dry air then mixes with air which has by-passed the dehumidifier to give a total circulation of 4,200 cu. ft per min with a moisture content of 0·65 grains per cu. ft. A steam heater is incorporated in the main air supply duct to heat the air during cold weather.

Assembly of glass panels.

From DC to AC Traction in Two Days

Changing the supply to the London-Southend line from 1.5 kV d.c. to 6.26 kV a.c. meant new control gear and signalling equipment, and modification of rolling stock. The changeover was carried out without stopping services.

AT FIRST sight the changeover from one electrical supply to another on a railway seems insignificant compared with the changeover from steam traction to diesel or electric traction. Nevertheless, the changeover from 1·5 kV d.c. to 6·25 kV a.c. that took place on the Liverpool Street-Shenfield-Southend line on the first weekend of November was a formidable and complicated operation. It entailed about 18 months of physical preparatory work and employed about 450 men. At one stage it seemed likely to call for a complete shut-down of the route to electric trains for three days. But careful planning led to a timetable giving a reduced service during the changeover period.

Work started on Friday evening and by Saturday morning a.c. trains were running over part of the route. To maintain services during work on the various sections, diesel railcars, diesel and steam locomotives, and special buses were called in. Newspapers and mail were diverted to alternative routes, and particularly important freight and parcel traffic was carried by road. Passengers were provided with free copies of the revised train timetable for the weekend.

During the preceding months, while preparatory work was going on, an intensive daily electric train service had been kept up, drawing current from overhead equipment that was gradually being adapted for subsequent a.c. operation. The conversion was undertaken to make the 41¼ mile line uniform with other routes in the East Anglian electrification scheme.

Work on the overhead lines equipment included the replacement of certain insulators, the provision of neutral sections between stretches of overhead equipment served by different sources of supply, alteration of switching and feeding arrangements, and the installation of booster transformers and return conductors (to reduce interference with telephone circuits).

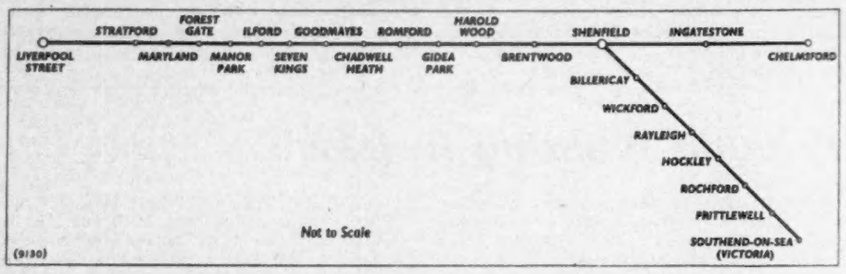
For practical and economic reasons the existing copper section of the 1·5 kV d.c. equipment has been retained, with little alteration to the existing portal structures. Both overlapping and section-insulator types of neutral sections have been installed. Where possible, new a.c. isolating and feeding switches have been mounted on existing switching structures. To enable a quick changeover on conversion, duplicate feeding arrangements were provided, a large number of specially uprated a.c. isolating switches being installed in order to carry the larger d.c. traction currents. Modifications to rail bonding have been comparatively minor.

Power supply arrangements are substantially as for the 1·5 kV system, but the existing feeder stations at Bethnal Green, Stratford, Chadwell Heath, Gidea Park, Ramsden Bellhouse, Rayleigh, and Prittlewell have been re-equipped with single-phase or Scott-connected transformers and 6·25 kV oil circuit breakers in place of the rectifiers and d.c. high-speed circuit breakers. Track-sectioning cabins remain substantially in the same locations as for the d.c. system. Protection and control circuits are similar to those of other sections of the East Anglian electrification scheme.

ROLLING STOCK

The 1·5 kV d.c. rolling stock amounted to 92 Shenfield three-car sets and 32 Southend four-car sets, built in 1949 and 1956 respectively. So far, 30 Shenfield sets have been converted to a.c. These, together with a.c. four-car multiple unit trains built for the London-Tilbury-Southend route, are being used to operate services over the converted route until all the existing d.c. stock has been dealt with.

The existing d.c. electrical equipment on the motor coaches remains, but the 1·5 kV d.c. supply originally taken direct from the contact wire through a pantograph on the motor coach is taken from transformer and rectifier equipment on the next coach, which has been altered to carry the pantograph collecting the single-phase alternating current. An insulated high-tension cable carries the line current to a 25/6·25 kV changeover switch mounted on a transformer. A fixed ratio secondary winding on the transformer feeds an air-cooled bridge-connected semiconductor rectifier unit. The direct current output is then taken by way of a smoothing choke and a semi-permanent jumper to the motor coach.



The Shenfield-Southend section of the route was converted first.

SIGNALLING

The signalling equipment associated with the running rails, essentially track and detection circuits, presented a special problem of conversion. The standard system compatible with d.c. traction was not compatible with a.c. traction, and vice versa. It was not feasible to change over from one complete signalling system to another in two days; so a new system was devised, compatible with both a.c. and d.c. traction.

An 83⅓ c/s system immune from interference from, first, the initial d.c. traction current and, now, the 50 c/s a.c. traction current has been installed. This has necessitated the provision of rotary frequency converters at the places where signalling power is taken. These machines consist of two alternators and a three-phase synchronous motor mounted in line, with adjustable mechanical couplings between the units. The alternators feed to two new power circuits provided throughout the lines concerned. One of the circuits is screened and the power carried is used solely for the local coils of the track relays. Elaborate precautions are taken to ensure that this feed remains completely free from 50 c/s voltages. The old 50 c/s power system has been retained for the established colour-light signalling.

WEEKEND SCHEDULE

On the weekend 4 to 6 November, work was carried out on substations, neutral sections, switching structures, and booster transformer locations. Sixty-eight booster transformers, 50 overlap spans, and 29 neutral sections required attention, the work mainly consisting of altering wiring to disconnect d.c. supplies and connect the new a.c. supply. All d.c. feeder switches had to be moved away and all a.c. feeder switches and neutral section switches had to be put in their working positions. Seventeen gangs of overhead line staff—four men to each gang—were employed on a shift basis.

Here is how the work went. From Friday evening to Saturday morning 11 gangs worked from Southend towards Shenfield, on both lines, completing the section. During this period a service of diesel trains and buses was operated.

On Saturday morning and afternoon, six gangs worked on the up and down main lines from Shenfield to Bethnal Green. During this time d.c. trains were still running over the up and down electric lines, together with steam and diesel trains diverted from the main lines. Operation of a.c. trains on the Shenfield-Southend branch had started.

During Saturday evening, five gangs worked on all lines between Liverpool Street and Bethnal Green and on the up and down electric lines between Bethnal Green and Chadwell Heath, including Ilford Car Sheds. Services between Liverpool Street and Shenfield were now maintained with steam or diesel trains only.

On Sunday, five gangs worked on the up and down electric lines between Chadwell Heath and Shenfield. By this time a.c. trains were working over the main lines between Liverpool Street and Southend. By Monday morning all lines had been converted.

During the Friday night to Saturday morning period, the new a.c. feeder equipment housed in the new buildings at Shenfield and Prittlewell was switched into operation. At Ramsden Bellhouse and Rayleigh feeder stations the existing d.c. equipment was disconnected and dismantled and the new a.c. equipment installed and brought into use. One of the rectifier feeder equipments at both Stratford and Chadwell Heath feeder stations was modified for use with the new transformers that supply a.c. current to the traction system. From 2 p.m. onwards on Saturday, two similar rectifier feeder equipments were dealt with at Gidea Park feeder station and equipment at all track sectioning cabins was brought into use as required, and as available. The remaining rectifier equipments at Chadwell Heath and Stratford feeder stations were then modified in the same way. During this period, certain signalling circuits that could not be altered previously were changed.

Apart from the coordination of technical work and the special timetable that made it feasible, there was the task of deploying the rolling stock at the appropriate times. Because of the amount of work involved, it was impossible to convert all the d.c. trains in readiness for the a.c. services. Ten of the Shenfield nine-car trains were dealt with, however, and entered service on the new a.c. system on Monday, 7 November. These were supplemented by 42 new eight-car a.c. trains ultimately intended for the London-Tilbury-Southend line.

Starting on 29 October, the new eight-car a.c. trains were worked into Ilford Car Sheds, a small number each day. There they were cleaned and tested before being hauled to their appropriate staging points. On Friday, 4 November, the ten Shenfield nine-car trains previously mentioned were placed in the Car Sheds at Ilford for final alterations to their wiring for a.c. traction. The remainder of the d.c. trains were gradually withdrawn on Friday and Saturday, to be placed in stabling sidings until being converted and returned to service, gradually releasing the new eight-car a.c. trains.

Dracone: New Cargoes, New Environments

The Dracone is taking over many of the functions of conventional steel barges. It is now widely accepted by operating companies, sailors and harbour authorities.

TWO years ago ENGINEERING (vol. 186, 3 Oct. '58, p. 440) described the early development of the Dracone by Dracone Developments Limited, under the aegis of the National Research Development Corporation. Since that time this revolutionary sea-going or inland waterways craft has operated successfully in countries as far apart as Canada and Borneo and, early this year, Dracone Operations Limited was formed, under the chairmanship of Admiral Sir John Eccles, G.C.B., to license, manufacture, sell and hire the Dracone in all parts of the world.

The brain child of three Cambridge engineers, the Dracone gets its name from the Greek word for "serpent" and, when afloat, it looks very like a serpent or—to the mundane 20th century eye unfired by Greek mythology—a huge and elongated sausage. Basically, the Dracone is a single compartment flexible towable container varying in capacity, at present, from 15 tons to 370 tons. It was conceived as a carrier of liquids lighter than water and its principal commercial use so far has been the transportation of diesel fuel, kerosine and gasoline, but further development has opened up possibilities for its use in the transportation and storage of other liquids and certain non-liquids.

The Dracone is now in regular use, or is about to be put into regular use in Nigeria, Australia, Borneo, Malaya, the West Indies, Canada and Germany. To date, the most common model is the D Type of 35 tons capacity, but the F Type 100 tonner and the K Type 370 tonner have also been ordered. The first of the K Type Dracones, launched last October, is shortly to be operated by the RAF in maintaining vital oil supplies to Gan Island in the Maldives.

CONSTRUCTION AND MATERIAL

In building these bigger Dracones, no new problems of construction or manoeuvrability have been encountered, and it is stated that a Dracone of at least 1,000 tons capacity could be built as soon as there is a demand.

It is the development of the skin material which has really made the Dracone possible. This skin or envelope is made of woven nylon fabric, a material of high tensile strength and tear resisting properties. The fabric is proofed on the inside with nitrile synthetic rubber (acrylonitile-butadiene) which provides a strong resistance to all kinds of petroleum products. On the outside the fabric is coated with neoprene which is oil-resisting and also withstands abrasion and the effects of salt water and strong sunlight.

In spite of its hard wearing qualities, however, the coated fabric of the 370 ton capacity K Type, for example, is only 0·25 in thick and, when empty, the complete envelope is just heavy enough to sink.

One shortage of performance data which hampered the Dracone inventors at first, was the lack of recognised drag figures for revolvable and flexible sausage-shaped objects. After computing their own drag figures, Dracone Developments have arrived at the shape which tracks best and keeps the nose of the craft up, and they have chosen a circumferential stabiliser of flexible material fitted near the tail end.

The extensive research and development work from which the Dracone has evolved is to be described by Professor W. R. Hawthorne, F.R.S., chairman of Dracone Developments Limited and co-inventor of the Dracone (the other inventors were two other Cambridge dons, Sir Geoffrey Taylor and Mr. John Shaw), in a paper which he is to give to the Institution of Mechanical Engineers on 25 January.

The Dracone's seaworthiness has been proved in the North Sea, the Bay of Fundy—an area notorious for high waves and complex tides—and, within the past few weeks, on a 500 mile tow in very rough conditions from Singapore to the Rejay River in Sarawak across the South China Sea. In addition, though, its docility and ability to turn within its own length give it marked advantages over conventional steel barges inland, even when towed in tandem or abreast. It has a shallow draught and its flexible construction makes it unlikely to suffer or cause damage.

It compares favourably with steel barges, too, on cost. The capital cost of the Dracone is rather less than that of more traditional carriers but the maintenance costs are considerably lower, and the fact that the Dracone can be transported overland or on board ship in a reeled up or otherwise deflated state means that it can be more fully utilised. There is virtually no maintenance required on the Dracone except for occasional bass-brooming of barnacles. In Southampton Water, this exterior cleaning is necessary every 3 to 4 weeks in the summer months.

Another operating economy is the fact that, in the view of the Ministry of Transport, the Dracone is neither ship nor vessel for the purposes of the Merchant Shipping Act, and therefore does not incur the expense of having to be registered, measured or assigned load lines. In the opinion of the underwriters, insurance of the Dracone presents no special problem, and premium rates on oil-carrying Dracones and their cargo are only very slightly higher than those for oil-carrying steel barges.

A number of port authorities in this country and abroad now accept the Dracone as a normal vessel and the Southampton Harbour Board—who should know, for their domain is the Dracone's home ground—have strongly recommended it. Permission for trials has also been given by the Tees Conservancy Commission, the States of Jersey and the Port of London Authority. The US Coastguard have also given permission with certain stipulations, while Rotterdam has approved its use in daylight.

FUTURE USES

Although its principal use to date has been as an oil carrier, there are many other types of transportation or storage for which the Dracone might be developed. Trials are starting in Malaya with palm oil, and a Dracone specially developed for fresh water transport—the LW1 to carry 450 tons—is now under construction. Fresh water carrying Dracones are lighter and much cheaper than the standard model and the possibility of using them for flood and earthquake relief is being studied. There is also the intriguing and heady possibility that the LW1 model to be used for supplying fresh water to the Greek Islands in the Aegean Sea will make the return journey to the mainland filled with wine.

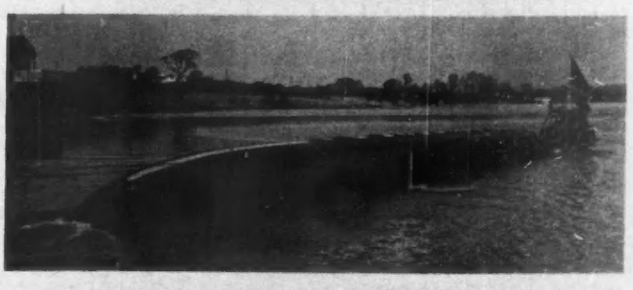
It is likely that the Dracone will also carry liquid chemicals, and one local government authority has inquired about its suitability for the transportation and disposal of sewage. The suggestion that the Dracone might be used for submarine towing has possibilities, but the practical difficulties of depth keeping make it unlikely that this idea will be developed quickly

Apart from carrying liquids, it is probable that the Dracone will be developed as a carrier of solids such as rice and grain. In the case of grain, the Dracone has the important merit of being hermetically sealed in transit. The feasibility of transporting sugar direct from London to Basle by Dracone is also being studied and the fact that it is equally at home in open seas and inland canals makes it particularly suitable for such straight through journeys.

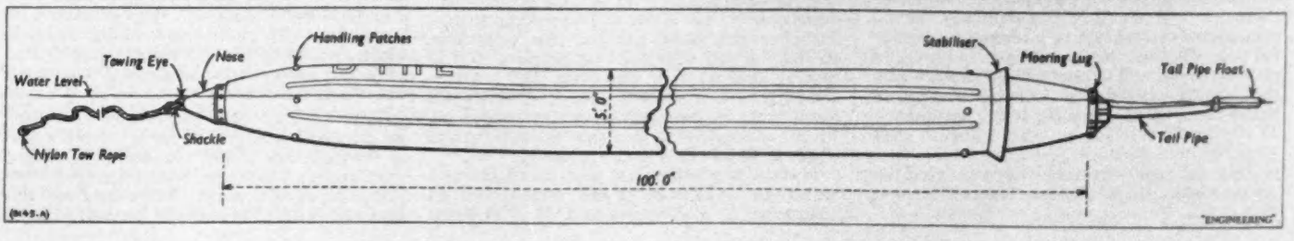
The possible developments and uses of the Dracone are so numerous that it is probably impossible to gauge its full potential at this stage. It is a revolutionary craft which might well have a more revolutionary future.

TABLE—*Dracone Vital Statistics (Approximate)*

Type letter ..	D	F	K
Capacity at 0·8 s.g. ..	35 ton	100 ton	370 ton
Imperial gallons ..	10,000	28,000	103,000
Length	100 ft	140 ft	200 ft
Diameter	4 ft 9 in	6 ft 9 in	10 ft 2 in
Maximum draught ..	3 ft 7 in	5 ft 1 in	7 ft 8 in
Draught, 80 per cent full	2 ft 0 in	2 ft 8 in	4 ft 0 in
Empty weight ..	1 ton 3 cwt	2 ton	6 ton 10 cwrt
Width of reel ..	9 ft	12 ft	17 ft 6 in
Reeled diameter ..	6 ft 6 in	7 ft	8 ft



The 35 tons capacity D Type Dracone (right) afloat and (below) on the drawing board.



On the Shelf

By Frank H. Smith

THIS is certainly the year for Penguin. And I do not mean the *cause célèbre* that will spring to the mind of 90 per cent. It is their 25th anniversary and I have received a delightfully produced commemorative number of *Penguins Progress*. Chapters deal with "From the Outside," with such contributors as Compton Mackenzie for the authors, Michael Grant for the teachers, Richard Hoggart for the readers and Reuben Heffer for the booksellers. "From the Inside" deals with the choice of books, production and design, selling abroad and advertising and promotion. I would suggest that any paper-back carpers should try to borrow a copy of this book. It might open their eyes.

I usually tell you about the articles in *Applied Mechanics Review* with a straight face and I will therefore forbear to make reference to overalls when I remark that the November item is "Mechanical Wear." It is by G. W. Rowe of the Tube Investments Research Labs. and, unusually, carries only 24 references. But he does say "Even in 1957 (2) there were over 20,000 papers referring to wear" and that bracketed 2 *may* be a reference to those 20,000 papers. I wouldn't know.

Those of us who have pinned our faith to the Institute of the Aerospace Sciences' "Aeronautical Engineering Index" for the past dozen years or so will be upset that, when it comes, the 1960 volume will be the last. I understand that IAS will "as of" January 1961 publish a new monthly, "International Aerospace Abstracts," with the backing of the National Science Foundation and the USAF. This will cost $20 to members, $40 to corporate members and $60 to all others. It will carry a prompter index—alphabetical by subjects and partly mechanised.

Had a publicity handout the other day from America which read "Shown above in this artist rendition is the . . . Albatross" (an aeroplane, in case you do not know). Just for the hell of it I refused to accept rendition and looked it up in the SOED: "Rendition (1601), The surrender of a place, garrison, possession, etc." Oh well !

William Heinemann Limited (Windmill Press, Kingswood, Surrey) announce a new "Science Study Series" of paperbacks in which five titles came out in September and a further six are forecast for early 1961. Leaflet available. There's quite a range of subjects but address your inquiry to 15-16 Queen Street, London, W1. At the same time they announce a half-guinea set of text-books in general science.

I see that congresses have their own directory. The Union of International Associations, Palais d'Egmont, Brussels 1, announce *The Annual International Congress Calendar* for the end of December at 18*s*. If you fork out 50*s* that includes a year's subscription to *International Associations*. As a matter of interest, the leaflet says that 1,400 international organisations are operating and 1,500 international meetings are held every year. And I do not think any grain of salt is required for *that*.

The Americans have found a new kind of deadline. I have a press release: "For release: only after successful orbit of Tiros II has been announced by NASA." The indication of an element of doubt shows, perhaps, a new humility?

Here is one of those first numbers for the announcement of which this column is so justly famous. *Nuclear fusion* is the "journal of plasma physics and thermonuclear fusion" from the International Atomic Energy Agency at Kärntner Ring 11, Vienna, at 21*s* an issue or £3 10*s* for the year's four. It's in English as far as we are concerned.

I like the postal frank on the envelope of *The Asia Bulletin*. It is "Forever Books," whatever that means.

Dynamics of Directories

Who Owns Whom, 1960. 3rd Edition. *O. W. Roskill and Company (Reports) Limited, 14 Great College Street, London, SW1.* (126*s*)

Who's Who in Atoms, 1960. Edited by A. W. HASLETT. 2nd Edition. 2 Volumes. *Vallancey Press.* (210*s*)

Electrical Who's Who, 1960-61. 6th Edition. *Electrical Review Publications Limited, Dorset House, Stanford Street, London, SE1.* (35*s*)

The International Year Book and Statesmen's Who's Who, 1960. Edited by L. G. PINE. *Burke's Peerage Limited,, 109-119 Waterloo Road, London, SE1.* (168*s*)

The hypothesis of continuous creation is one which must commend itself to compilers of directories, whose fate it is to see their work already in some degree out of date when it is published.

The life of a directory may be viewed as a process of decay, with the information contained becoming progressively less true with the passage of time, and no doubt a definite statistical pattern exists governing this deterioration. Even when a directory is superseded by later editions it still has historical value as a "snapshot" of the time it was compiled.

Plainly then, the most we can ask of the compiler of directories is that entries should be accurate at the time of compilation, and that the time taken to compile the work should not be so long that an undue percentage of the entries will have become inaccurate on publication. As most biographical directories rely on information supplied by the individual concerned, the worth of the directory is thus affected by each one of us as we submit or fail to submit our answers to directory circulars.

An evaluation of a directory by an individual can be based only on a small sample of the total entries, and even then, except in the cases of people known personally, it is not possible to verify each particular. All in all, the recognition of the usefulness and reliability of a directory is built up only over a period of time, and through the usage of very many people.

Of the four works under consideration, two of them, *Who Owns Whom* and *Who's Who in Atoms*, are still young in years.

Who Owns Whom is a directory of parent, associate and subsidiary companies in industry and commerce. It first appeared in June, 1958, with subsequent editions in 1959 and 1960, which indicates that there was a demand for a work of this kind. At first it was divided into two volumes, but the present edition, although listing a larger number of subsidiary companies, appears in a single volume, and is correspondingly easier to use. Other new features of this edition are a list of United Kingdom companies showing associated and subsidiary companies in the European Common Market, and a list of United States companies showing UK associated and subsidiary companies. The main work aimed to be accurate to 31 March, 1960, while an addendum gives changes of ownership of public companies to 30 April, 1960. Altogether this is a work which can be expected to establish itself over the years.

Who's Who in Atoms first appeared in 1959, and was out of print within two months of publication. That such a demand existed is not surprising when one considers the large number of organisations all over the world which are engaged in nuclear research and development, and indeed, the publishers state that over a thousand agencies and many thousand of industrial firms from over seventy countries have cooperated in the preparation of the present two-volume edition. Entries include useful details of papers written. The very bulk of the work is now one of its disadvantages; the use of a less bulky paper and a smaller type face could have resulted in a more compact and cheaper work without any loss of legibility.

Electrical Who's Who, 1960-61 compiled by *Electrical Review*, provides brief biographies of leading members of the professional and industrial branches of the electrical and allied industries and professions. It is now in its tenth year of publication, and this survival shows that it has fulfilled the criterion of having been found useful by many over a period of time. The work is not overloaded with advertising material and the text includes a list of abbreviations; there is also an index of entries arranged under the firms and organisations served, and an obituary list. It is well produced, pleasant in appearance, and both typeface and paper have been chosen for the highest degree of legibility allied with compactness, which features could well serve as a model for publications of this kind.

The International Year Book and Statesmen's Who's Who, which appears in its eighth edition, is divided into three sections. Part one includes a series of short review articles on current topics of interest to commerce and industry, a directory of international organisations, organisation charts for the "Foreign Ministries of the Five Great Powers," and a short black-and-white map section. Part two is devoted to information regarding the various states of the world, while part three is the biographical section. The work is well bound and printed.

All of these works have been found useful in a busy library and information service, and such inaccuracies as have been detected are consequent on the change which is after all the prime reason for the continuing existence of directories such as these. Their editors well know that their survival depends on their continuing vigilance.

H. THOMPSON

Adaptation Mechanics

Design for a Brain. By W. ROSS ASHBY. 2nd edition. *Chapman and Hall.* (42*s*)

Norbert Wiener wrote the first classic of the science of organic control, when he produced *Cybernetics*. Ross Ashby wrote the second, and *Design for a Brain* is its title.

This may be a bold claim to make for a book first published in 1952; but ask any professional cybernetician: the claim is completely convincing. For this book was the first systematic attempt to say, with scientific precision and a general validity, how the brain can possibly exhibit behaviour which has purpose, which can learn from its own experience, and above all which can *adapt* to changes in the outside situation which could not be predicted.

It is the last feature that is so important, and which Dr. Ashby built into his account of ultrastability. For we live in a world in which computers, our most advanced control mechanism, have to be programmed *in advance* to deal with every contingency that can be foreseen *in advance*, by methods which must be exactly prescribed *in advance*. But the essence of a natural control system like the brain is that it can adapt itself to unforeseen circumstances, by taking action which has not been preordained for it in detail by the designer. This is nature's big lesson for us in control technology; a lesson which Dr. Ashby heard, understood, and interpreted for science in the language of science. It was a high achievement.

Since 1952, his book has become a vital text for advanced cybernetic thinking: every worker in the field has simply assumed (with reason) that Ashby's discoveries were common ground, just as a physicist would assume the Newtonian laws of motion to be common ground. Outside

the field, inevitably, Dr. Ashby has been attacked. Some psychiatrists have said that the brain could not work like that: they forgot that Ashby is a professional psychiatrist. Some biologists, overcome perhaps by a feeling of awe for Nature (with a capital N), declared violently that the wonders of the universe could not possibly be reduced to a series of dry mathematical comments: they forgot the history of science, from Gallileo to Einstein.

Most amusingly of all, the "drier" scientists themselves (and they have included some engineers) complained about Dr. Ashby's flair for self-expression; they complained about the title of his book (which is fun), and they complained that "all he had done" was to demonstrate certain "evident" characteristics of systems that left the real mysteries of brain-like behaviour unexplained. They forgot that an explanation is precisely the debunking of mystery.

For what could possibly count as explaining how the brain works? We must beware of saying that anything that actually offers such an explanation cannot be right, because everyone knows that no explanation is available. What Ashby has done is to look at the facts, to take over most ingeniously some mathematical tools devised by French mathematicians, and to propose a theoretical mechanism that accounts for the facts. He does not pretend to explain the neurophysiology and biochemistry of the brain: he is interested in the kind of *system* that could produce adaptive behaviour—and has built a hardware version that does so (his famous Homeostat). Now, even if the biological scientists still complain that this interpretation does not say enough to explain the living brain, there is no reason why engineers, and industrial control scientists in particular, should care. They can *use* this discovery—now.

The second edition of *Design for a Brain* is a complete revision of the earlier work—so complete a revision that it is a pity that it has been published under the same title. Readers of the earlier version may be tempted not to bother with it on this account, and they would be mistaken. Dr. Ashby is a perfectionist: he has obviously taken infinite pains to make his work yet more clear, yet more elegant. In the process, some of the first edition has been expunged. From the mathematical point of view this is advantageous; but it is sad to find that the account (for instance) of the interesting adaptive behaviour of the pond animalcule *Stentor* has not survived, and that the index is less copious than before. But, despite cuts, there has been sufficient new material added to increase the length of the book by thirty pages.

The new edition provides a good opportunity for old admirers of this work to refresh themselves by reading the revised version. Those who have never tackled the work at all might well do so now; in the confidence that although it is difficult terrain, their author has spared no effort to conduct them through it with rigour, exactness, sufficient explanation, and great courtesy. To such new readers, who know all about orthodox control theory, the new vision of a sentient control mechanism that can in principle cope with the unexpected should be a revelation.

STAFFORD BEER

Machine Tools Numerically Controlled

Progress in Automation. Volume 1. Edited by ANDREW D. BOOTH. *Butterworths Scientific Publications.* (42*s*)

Numerical control of machine tools forms an important sector in the development of automatic production methods. To those wishing to exploit such processes, this volume is addressed. It is the first in a series covering the latest developments in automation, designed so that "the industrialist and his production and development team will gain a thorough understanding of the many specialist problems which arise in all phases of the field."

In order to assess the usefulness of the book it is necessary to consider the way it has been compiled by the editor and his associates and it will be seen that following an introduction, including a brief history, by the editor, the book is then divided into two parts with contributions from eleven different authors each an expert in his own particular field. Part One is headed "Methods" and deals mainly with the techniques used for measuring and processing the information required for automatic control, while Part Two is concerned with the application of complete control systems. Since the field covered in each part is very wide, it is felt that a better appreciation of the book may be obtained from a few notes concerning each contribution.

The first paper deals with the methods employed for the conversion from analogue to digital information (and vice versa), together with a detailed analysis of a particular voltage-to-digital converter and its application in computing. Next is a paper concerned with data processing by computer in process control systems and the trend towards overall computer control of complex plants.

The third and fourth papers are both concerned with the numerical control of machine tools and in particular with an automatic method of positioning machine slides and a precise method of measuring table position. The topic changes again for the two final papers in Part One, which consider the advantages and limitations of nucleonic gauges for industrial measurements such as material thickness and fluid density.

It will be seen from the above brief review that part one covers a wide range of interest which is repeated to a lesser extent in part two. The first and second papers outline in some detail the underlying design philosophies of two distinct types of system for the numerical control of machine tools; both systems are well known, but one is based on digital and the other on analogue computation and control. The next paper changes the emphasis from the automatic control of machine tools to automatic control in the steel industry and in particular to the control of thickness during the manufacture of steel strip, while the final paper considers the implications of automatic methods of control upon inspection procedures.

The main difficulty in attempting to assess this book is the variation in breadth and depth of the papers presented. Although all are well written and quite readable (if a technical publication can be termed readable), the papers related to process control are much more general and less detailed than those on numerical control of machine tools. Presumably because of this difference in approach, the latter papers generally have much more extensive references and bibliography. It would appear that to some extent these papers fall between two stools—a broad general review and detailed examination—and careful thought will need to be given to the balance in future volumes.

But, after giving due consideration to the above points, the book can certainly be recommended to the industrialist and his production and development team concerned with automatic methods of production and wishing to learn more about the possibilities opened by the numerical control of machine tools. It will not, however, help him to make the necessary economic assessment of their possibilities since this is a field requiring detailed figures obtained in practice to support (or otherwise) the optimistic hopes and carefully selected examples of the manufacturers.

C. J. CHARNLEY

Editorial Practice in Keeping with the Topic

Handbook for Chemical Society Authors. Special Publication No. 14. *Chemical Society, Burlington House, London, W1.* (21*s*)

It is a strange component of human nature that makes us all ever ready to polish up a manuscript, to improve a draft, to correct the English, or to substitute our turn of phrase for that of an author. This propensity to alter a text is an occupational disease of editors—at any rate at the beginning of their career—and, let it be added at once, the work of many young authors is greatly improved as a result.

However, publications differ in nature and content and the subject matter of a humorous magazine calls for a treatment different from that of a highly technical journal devoted entirely to new work in a rapidly developing field.

The publications of the older learned societies, those with a century or so behind them, show a steady development, and usually a steady improvement, in presentation and appearance. Many learned societies were indeed founded to provide an avenue of publication for the work of their members. Life was then more leisurely, time was less important, specialisation as we know it today had not arrived. Any educated man could reasonably expect to understand a fair part of the contents of any learned journal. This is no longer the case today.

The situation now is completely changed, for not only is specialisation so advanced that a subject such as chemistry is subdivided into a number of quite distinct sections, but the sheer volume of work clamouring to be published makes condensation and contraction an essential prerequisite to acceptance for publication.

The situation of the author has likewise changed. It was not unusual in years gone by for him to subsidise the cost of publishing his article, particularly if it included illustrations. No question of any payment to an author ever arose and he was lucky to be given a small number of offprints of his paper for distribution to his friends and colleagues without charge. It was equally unusual, at least at the commencement of a new journal, for the editor to have to exercise any kind of censorship because of pressure on his space. Those days, so pleasant to the would be author, have gone, never to return.

A further change of great significance is in the status of the author. Originally he was an amateur working on his own. The day of the operational team, the research department and, in particular, the day of the research association and of state departments of science had not dawned. As a result of the last change many new factors have appeared. The true amateur has virtually disappeared and he has been replaced by sponsored workers. This situation has led to further complications for new interests have appeared. A manufacturing company has a real interest in advertising itself and its pro-

ducts. A research association is interested not in 25 offprints of a paper for the use of the author but in hundreds of copies for distribution and exchange. It is clear that conflicting interests can, and in fact do, arise. And the result of it all is an increasing attention to detail in the contents of papers accepted for publication.

In olden times the editor of the organ of a learned society was a colleague of his authors and he acted in an honorary capacity and probably carried out his office in his spare time and in his own house. Clearly he could exert little or no influence on the finished article beyond ensuring that the contents of any issue of his journal conformed to a certain typographical standard. Indeed, it is probable that in many instances even this was the result of the printers efforts and not those of the editor.

Today the editing of a scientific journal is a highly skilled job. Layout and make-up call for little more than experience, but real skill is required to ensure the best results, both for the author and the reader, in presentation, in content, and in the reproduction of the illustrations as well as their placing in the text.

The *Handbook for Chemical Society Authors* is highly specialised as its title indicates. It is very clearly written and sometimes its language is plain almost to the point of bluntness, but this observation is not meant as a criticism, for such a book should indeed be a manual to be followed and instructions, to be of use, must be clearly expressed.

Much of its contents relate to such matters as chemical nomenclature, structural formulae, new compounds, tables and references. It does not aim to dictate style and in the view of the reviewer this forbearance is correct. It is indefensible in his view for an editor to presume to dictate on style except where the author's style is unclear or confusing. It is a defensible thesis that an author's style is an expression of his individuality and as such should be respected.

Not only must the author of a paper offered to the Chemical Society satisfy the Publications Committee that his work is concerned with new results, he must also ensure that his presentation is economical and clear. "The Editor is instructed to insist on economy in phraseology."

The book is addressed to those who seek to have their work published by the Chemical Society. As such it is of the greatest value. The highly specialised chapters on nomenclature occupy the greater part of the book and are not of general interest. The remainder is indeed of general interest and could well find application in a much wider field.

FRANCIS J. GRIFFIN

New Books

Information and Decision Processes. Edited by ROBERT E. MACHOL. *McGraw-Hill, New York and London.* (46*s*)

In April, 1959, a Symposium on Information and Decision Processes was held at Purdue University; here are published the ten papers presented, together with two from the previous conference.

A Short History of Technology. By T. K. DERRY and TREVOR I. WILLIAMS. *Oxford University Press.* (38*s*)

Although this work owes much to the five-volume *History of Technology*, it is no mere abridgment, but relates the story of technological development to the general historical background.

Fuel Cells. Edited by G. J. YOUNG. *Reinhold, New York; Chapman and Hall, London.* (46*s*)

Based on a symposium held by the Gas and Fuel Division of the American Chemical Society, the present volume brings together papers from this country and the USA on the current state of fuel cell research.

Theoretical and Experimental Physics. By H. G. JERRARD and D. B. MCNEILL. *Chapman and Hall.* (75*s*)

The extensive field covered by modern physics makes it increasingly difficult to acquire both the theoretical knowledge and the manipulative skill required, within the bounds of a normal degree course. The present book sets out a large number of fundamental experiments and techniques, and may be used as a reference by those engaged in study, industry or teaching, or as a manual in a laboratory course.

The Theory and Design of Inductance Coils. By V. G. WELSBY. 2nd edition. *Macdonald.* (30*s*)

The author's main purpose in this book is to explain the underlying design principles of all types of inductors in a convenient way for practical application, rather than to give an exhaustive mathematical treatment. The new edition introduces electromagnetic field theory, and adopts mks units.

Hover Craft. By ANGELA CROOME. *Brockhampton Press.* (15*s*)

A fascinating and well-produced account of ornithopters, autogyros, helicopters, VTOLs and hovercraft, sufficiently up to date to include the Levacar, the Short SC-1, and the Cushioncraft. Aimed primarily at younger readers, but should not be denied to their elders.

Symposium on Effects of Water-Reducing Admixtures and Set-Retarding Admixtures on Properties of Concrete. ASTM Special Technical Publication No. 266. *American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.* ($7·50, *members* $6)

The use of water-reducing admixtures and set retarders in concrete has grown continuously since their introduction over 25 years ago, with a present estimated usage in the production of 25 million cubic yards of concrete annually in the US alone. Ten papers were presented at the symposium by producers, users and researchers.

Modern Workshop Technology. Edited by H. WRIGHT BAKER. 2nd edition. Part 2. Machine Tools and Manufacturing Processes. *Cleaver-Hume Press.* (55*s*)

In the new edition several chapters have been completely rewritten and a number of new topics introduced. Among these are ultrasonic and electrical machining, and the intricate problems of surface finish.

Radiation Pyrometry and Its Underlying Principles of Radiant Heat Transfer. By THOMAS R. HARRISON. *Wiley, New York and London.* (96*s*)

The prime purpose of the author in preparing this book has been to present the subject of radiation pyrometry in enough theoretical and practical detail to enable operating engineers to arrive at definite answers to actual problems occurring in industry.

Power Without Property. By ADOLF A. BERLE JR. *Sidgwick and Jackson.* (15*s*)

The high taxation of the 20th century and the growth of the public company methods of finance have led to a new propertied class in the United States, the scattered and diversified stockholders, who, although they own the businesses, do not control them. Power resides with the directors both of the company itself and of the insurance companies, pension funds, and trusts who are the main suppliers of new capital.

Railwayman. By CHRISTOPHER VINCENT. *Lutterworth Press.* (10*s* 6*d*)

A fascinating account, mainly in pictures, of the development and growth of the railways, the feats of the great engineers, the advent of the diesels, and the present work of reorganisation, subtitled "A Picture Career Book."

More Unusual Railways. By JOHN R. DAY. *Frederick Muller.* (21*s*)

Continuing the story begun in *Unusual Railways*, the author describes early attempts to drive rail vehicles by horse and sail power, and later proposals and systems using guide-rails, moving platforms, and the Talgo principle. A quite full account is included of the various types of monorail system.

Information Processing: Proceedings of the International Conference on Information Processing, UNESCO, Paris, June 1959. *UNESCO, Paris; Butterworths, London.* (147*s*)

A total of 59 papers were presented at the conference, under group headings devoted to methods of digital computing, common symbolic computer language, automatic translation, machine learning, logical design of computers, and computer techniques of the future.

The Brittle Fracture of Steel. By W. D. BIGGS. *Macdonald and Evans.* (70*s*)

A brief summary of service failures introduces an extended discussion of the factors which influence the response of metals to plastic flow, viewed in the light of current theories of the initiation and propagation of fracture. Various test methods used to evaluate the susceptibility of a steel to brittle fracture are described.

Principles and Practice of Aircraft Electrical Engineering. By H. ZEFFERT. *George Newnes.* (90*s*)

The Vickers Viking, designed in 1945, had a total continuous power available of 6 kW; in 1960 the Vickers Vanguard has a total continual power available of no less than 300 kVA. This comparison suggests the degree of change which has taken place in aircraft electrics, and which has demanded an up-to-date approach to the whole field.

War Planes of the Second World War: Fighters. Volume 1. By WILLIAM GREEN. *Macdonald.* (9*s* 6*d*)

The first volume of a new series (of which three are to be devoted to fighters and fighter-bombers), covering the military aircraft of all the participant countries. Photographs and drawings, history of used, and technical details are given in the present volume for fighters from Australia, Belgium, Bohemia-Moravia, Finland, France and Germany.

The Reviewers

Mr. H. Thompson, F.L.A., is senior librarian in the Nuclear Power Group (TNPG).

Mr. Stafford Beer is head of the Operational Research and Cybernetics Department of the United Steel Companies Limited.

Mr. C. J. Charnley is lecturer in automatic production and control in the Department of Economics and Production at the College of Aeronautics, Cranfield. He is a member of the Society of Instrument Technology and was previously head of the National College of Horology and Instrument Technology.

Lt.-Col. F. J. Griffin is editor-in-chief of the *Society of Chemical Industry*.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Handbooks

Pipework. STEWARTS AND LLOYDS LTD., Brook House, Upper Brook Street, London, W1. *Industrial Pipework* is the title of an illustrated brochure of 53 pages in which full details are given of pipe sizes and capacities and notes on manufacturing processes.

Coal Preparation. HEAD, WRIGHTSON AND CO. LTD., 20 Buckingham Gate, London, SW1. A 20 page brochure describes with photos and cutaway drawings the company's various coal preparation plants.

Communications. AMPLIVOX LTD., Beresford Avenue, Wembley, Middlesex. The company's products of microphones, amplifiers, headphones and ear guards are described in an illustrated loose-leaf catalogue.

Aircraft Equipment. ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY) LTD., Rugby. The wide range of the company's switches, starters, amplidynes, rectifiers, and lighting equipment as used in aircraft is outlined in a 64 page illustrated brochure.

Trial Pits. SOIL MECHANICS LTD., 65 Old Church Street, London, SW3. The digging of trial pits and shafts with plate bearing tests is described in an illustrated 8 page pamphlet.

Driers and Furnaces. AEI-BIRLEC LTD., Tyburn Road, Erdington, Birmingham 24. The firm's furnaces and driers at work in industry; 8 pages of illustrations and descriptions.

Glues and Resins. CIBA (A.R.L.) Ltd., Duxford, Cambridge. *An Introduction to Duxford* describes the works and the glues and resins made there. 20 pages illustrated.

Bar and Rod Mills. BRIGHTSIDE FOUNDRY AND ENGINEERING CO. LTD., Ecclesfield, Sheffield. Bar and rod mill installations are shown in colour and in perspective drawings in a 20 page brochure.

Durgapur. C. S. SERVICES LTD., 5 Carlos Place, London, W1. Facts and figures of the steelworks constructed by Iscon at Durgapur are given in a 16 page illustrated booklet.

Marketing

Exhaust Brakes and Cattle-Mattresses

TRACTORS fitted with exhaust brakes which slow the machine down by creating back pressure in the exhaust system (DAVID BROWN); a "vacuum" cleaner for deep litter houses which delivers the material through chute and ducting for delivery outside the House (BECFABS Limited, Beccles, Suffolk); a portable flexible conveyor-auger which moves liquids, grain, meal, flour and similar substances round corners and over obstacles at a rate of up to ten tons an hour (LUNDELL Limited, Edenbridge, Kent); and plastic cattle-mattresses (the GOUROCK ROPEWORK Company Limited, Port Glasgow, Scotland) were among new machinery and equipment at the Royal Smithfield Show, at Earls Court, London, (5 to 9 December.)

The conveyor-auger, well named the Snauger, has two helices, one running within the other at twice its speed and in an opposite direction. The scissors action thus created provides the drive. The casing is of coiled metal construction.

The cattle-mattresses, or Kowlays, as they are called, are further described by their makers as "... tapered cushions of durable polyurethene foam completely sealed by radio-frequency welding in an outer cover of impermeable Birkmyre's nylon "PluViaC" cloth."

The amount of new machinery and equipment from overseas seemed larger than in previous years. There were the German Lemken three-furrow mounted reversible plough (COLCHESTER TILLAGE Limited, Colchester, Essex), the Danish Kvikmulder mulcher, front mounted on a tractor and projecting up to 10 ft on one side of it, for mulching difficult-to-get-at grass in orchards (MI-DOX Limited, Smarden, Kent), and the Belgian Melotte cultivator for use with the shallow planting of potatoes, with its three groups of circling vertical blades to create a fine tilth, its three trailing ridgers to make clod-free ridges (MELOTTE SALES Limited, Grantham, Lincs.). Among American equipment was a small compact machine—collecting basket, bucket, heater, thermostat—which cleans eggs in a warm sanitant with a gentle reciprocal motion, clockwise and anticlockwise. Some 300,000 of these machines are already in use in the United States, where the wet cleaning of eggs is standard practice (GASCOIGNE-CROWTHER Limited, Caversham, Reading).

Foot and mouth disease prevented the showing of any livestock at the Show this year, the first on which it has carried the title "Royal."

Laing Subsidiary in African Housing Scheme

Following an agreement between the Southern Rhodesian Government and AFRICAN DEVELOPMENT (PVT) Limited, a company jointly owned by LAING DEVELOPMENT (RHODESIA) Limited and a Southern Rhodesian investment company, work is to start immediately on 1,000 houses and three schools at Salisbury, Southern Rhodesia.

As each block of houses is completed African families will move in. Eight hundred of the houses will be three roomed and terraced. 180 will be four roomed and semi-detached. All the houses will have water and electricity.

The Highfield scheme will employ 300 European and African artisans and labourers. The scheme's first stage should be complete by 1962.

The houses and schools will be rented from African Housing Development Limited for 30 years by the Southern Rhodesian Government who will then take over the full ownership.

Earlier this year the Laing company announced that it was running down its interests in the Union of South Africa but would still be able to tender competitively for certain contracts.

Office Machinery Exports Again Exceed Record

Another industry able to celebrate passing last year's export figures with only ten months of the present year yet reported on, is the office machinery business.

This will be the fifteenth successive year in which the office equipment manufacturers have increased their export performance. Including October their shipments overseas this year have reached a value of £29·6 million, against £29·5 in the whole of last year.

The OFFICE APPLIANCES AND BUSINESS EQUIPMENT TRADES ASSOCIATION records that some of the best improvements were in typewriters (£3·45 million against £3·22 million for the whole of 1959). Accounting machinery was up from £6·1 million to £6·3 million. Duplicators also did better.

Australia, South Africa and the United States were still the leading customers and all took slightly more equipment. Italy, who imported £292,768 worth of office machinery in 1959's first ten months, this year took equipment worth £736,720.

Export Marketing Help in the Middle West

On the principle that the bigger the market the better the chances, it is understandable that many of the companies now looking round for a way of breaking out of total dependence on the home market are casting an eye over the opportunities in the United States.

The straightforward leap into making the firm's products available in North America is by no means the only way to turn knowledge and experience to account.

There is a great deal to be done with the sale of "intellectual property," i.e. patents, processes and trade marks.

If this is to be attempted it is important to have some expert advice from the other side. The Board of Trade and the special departments of the Federation of British Industries are well known for their readiness to assist with advice. There are also United States firms of consultants who have the advantage of playing the game on their home ground.

One of these, in a special position to develop UK associations with American companies in the fast growing Middle West of the USA, is the consultancy of THOMAS H. MINER AND ASSOCIATES, of Chicago.

The services of this firm are ope not companies considering the move into export activities and to those who have already begun to develop international interests. The list of consultant functions is naturally a lengthy one. Most interesting, perhaps, are those of finding capital overseas for joint ventures, negotiation of joint venture and other manufacturing facilities abroad, supervision of international operations at home and abroad, the determination of the best financial and tax arrangements and the sale of intellectual property.

New Emphasis on Industrial Market Research

Interest in industrial market research has heightened rapidly in recent months. A few weeks ago a major seminar on industrial market research was organised by the British Institute of Management, and one of the first courses on the subject ever to be held in Britain began at London's Regent Street Polytechnic. Meanwhile, scarcely a week goes by without a well known company advertising for industrial market researchers.

Many large manufacturing organsiations in engineering and allied fields have by now set-up their own industrial market research departments. They include the Hawker Siddeley Group, AEI, Mullard, Standard Telephones and Cables, Ferranti, Metal Box and others. The number is growing weekly.

Some companies like Hawker Siddeley, Ferranti and Metal Box have had industrial market research departments for a number of years, and there are other examples of well established industrial market research set-ups. AEI, Standard Telephone and Cables and Mullard have established their departments over the last year or so.

Specialists Called in

In many cases, these internal organisations comprise a central nucleus of experienced staff, but much of the detailed survey investigation is commissioned from outside specialist organisations.

Without doubt the largest independent company in industrial market research is the Economist Intelligence Unit. An example of the rapid growth of companies in this field is Marketing and Economic Research Limited. Established in 1958 it now employs a number of specialists with engineering and chemical and economic background a well as eight full time graduates, and its clients already include some of the best known manufacturing companies in Britain.

Industrial Market Research is a post war development which has only taken root over the last five years. Indeed its only in the last two to three years that interest has really been accelerated.

Small Beginning

While the 1950's saw a considerable spurt in interest in consumer goods research—led by the packaged goods industries and followed much later by consumer durables—emphasis in the 1960's is likely to be increasingly on research into industrial markets. This research will cover markets for plant and equipment, for raw and semi-finished materials, and indeed for any products or services being sold to industry rather than to private consumers.

At present, the amount being spent on industrial market research is but a fraction of the sum spent on consumer goods research. Industrial market researchers have evidently been too busy to survey how big the market really is and to assess the value of work carried out by internal and external organisations. One estimate suggests that it is in the order of £1 million p.a. It may well be more. It is obviously going to grow very considerably.

Industrial market research has developed later than research into consumer goods markets, but not because the value of industrial markets, in terms of pounds sterling, is any lower than that for consumer goods. The truth is that research into consumer goods is, by and large, much easier in many ways, and developments in research methods had clearly to take place before it was possible to develop suitable methodology for serious industrial market research.

Possible Projects

What types of management problems does industrial market research attempt to solve, whether undertaken by outside specialist organisations or internal departments? Broadly they can be divided into three groups.

(1) Investigations into prospective markets for new products.

(2) Surveys when manufacturers are considering expansion of capacity, or entering a field for the first time as part of a policy of diversification. Here, increasingly, outside surveys are carried out to assess the size of the market, its rate of growth, competitors' shares and the factors which influence the overall scale and growth of markets.

(3) Frequently companies undertake or commission market research where for one reason or another they feel that their existing share of the market is too low. In such cases, they are interested not only in an objective assessment of the market and its prospects, but also in a possible invesigation into the marketing operation of competitors and the factors influencing their success.

How much do surveys cost? This obviously depends on the product and the extent of the research involved. Where research requires investigation into a product used in a large number of industries, then, clearly, the cost will be very much higher than where a survey is concerned with a product which is used in a narrow sector of industry.

Large Cost Range

Major surveys in the former category, which might also embrace coverage of a number of competing materials in a wide range of user industries, may take from four to six men-months to work to complete and could cost in the order and upwards of £2,000 to £3,000. It all depends upon scale. Industrial market research is not confined to large companies. Many surveys are carried out for fees in the order of a few hundred pounds. At the other extreme, because of their complexity and breadth of coverage, some surveys cost more than £3,000.

Increasingly, managements expect market research units to investigate not only markets, but methods of marketing. These often include price policy, form and organisation of sales representation, including optimum frequency of calls, promotional methods and the extent of technical and advisory services to be provided.

Choosing a Course for Space Navigation

Lunar landings, first with instrument packages and then with men, are scheduled for the near future. More ambitious spaceflights are expected to follow. Techniques for navigation have still to be finalised.

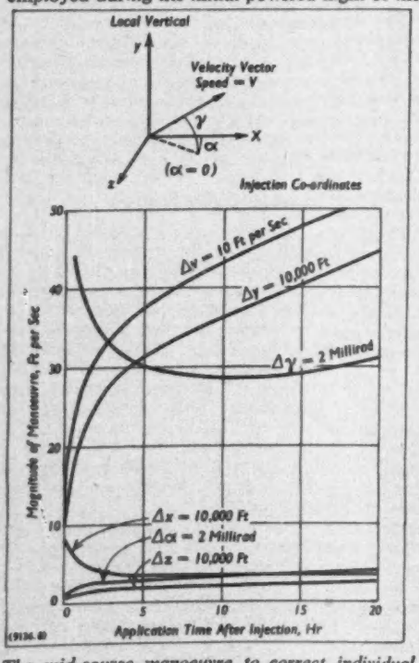
By G. V. E. Thompson, B.Sc., B.Sc.(Eng.), A.R.C.S., F.B.I.S.

THERE was a last-minute withdrawal of two of the six papers scheduled for presentation at a one-day symposium on Navigation and the Early Exploration of the Moon, recently held by the British Interplanetary Society and Institute of Navigation in London. The two papers had been submitted by the US General Electric Company, but had to be withdrawn for security reasons—an indication of the importance attached to the subject. As it turned out, however, the remaining four papers and the full discussion which followed fully occupied the available time.

The first speaker was Professor Samuel Herrick of the University of California, Los Angeles, who flew over "between lectures" to attend the meeting. He discussed the demands of nearly parabolic lunar trajectories on differential correction and perturbation theory. This is a core problem in the navigation of space vehicles to the Moon. Existing mathematical techniques are limited in that either they will not handle the rectilinear orbit or else they have a discontinuity between parabola and hyperbola. Professor Herrick remarked that when the mathematics involves division by zero, computing machines seem to go up in smoke rather than become philosophical about it as a mathematician would be.

The paper developed an ephemeris procedure that was continuous through elliptic, parabolic, hyperbolic and rectilinear orbits. The basic formulae were extended to differential correction and to the treatment of perturbations by variation of coordinates and by variation of parameters.

Navigation during a voyage to the Moon can be divided into three phases. First there is injection, boost or ascent guidance, which is employed during the initial powered flight of the vehicle and is intended to ensure that the spacecraft is "injected" into the computed orbit along which it will coast to its destination. The techniques are much the same as those used in the guidance of ballistic missiles, but injection guidance alone is not sufficiently accurate for advanced missions. It is therefore necessary to apply small corrections to the trajectory during the long coasting stage of the flight, and this is done by small impulses applied by firing a small rocket motor mounted in the spacecraft—mid-course manoeuvres. Finally, when the payload approaches its destination it is necessary to fire retro-rockets to retard the speed and to guide the probe to the selected landing place—terminal guidance.



The mid-course manoeuvre to correct individual errors (66 hr lunar impact trajectory).

1962 LUNAR LANDING

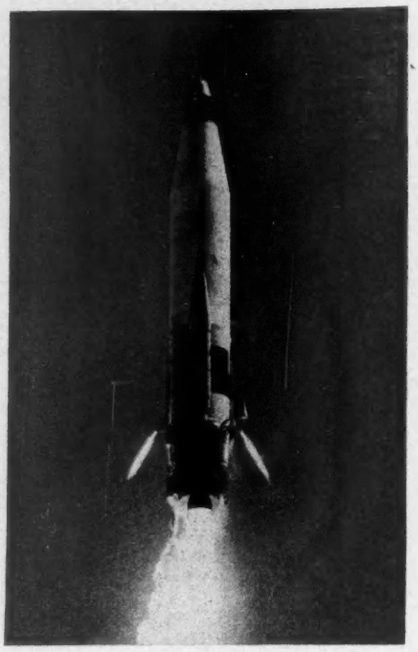
Mid-course guidance of space vehicles by radio measurements and command was dealt with by Dr. A. R. Maxwell Noton, who has recently joined the Electrical Engineering Department of the University of Nottingham, after working at the NASA Jet Propulsion Laboratory at California Institute of Technology. The mid-course manoeuvre theory he outlined was developed for the Ranger programme, which is intended to rough-land a 300 lb instrumented capsule on the Moon, using an Atlas-Agena B booster. The first flight of the system is planned for 1961 and the first lunar landing for 1962.

In the Ranger system, only one manoeuvre is needed. The magnitude and direction of the correcting impulse is computed on the ground from radio measurements and the appropriate commands are sent to the probe. Early spacecraft (such as Pioneer IV lunar probe) carried only a radio beacon for tracking purposes, and only angular measurements were possible. Doppler measurements were dependent on the stability of the probe transmitter, so that velocity data were virtually useless. Pioneer V and later Probes carry a phase-coherent receiver and transmitter so that accurate measurement of the velocity is possible.

Tracking sites for lunar and interplanetary probes are being set up at Goldstone, California, at Woomera, and in South Africa. Each site will have two 85 ft diameter antennae—one for transmitting and one for receiving—and in addition to sending commands to the probes will be able to determine the angular position, range-rate, and (ultimately) the range of the probe. They will be linked with the main computing centre in the USA so that the data can be processed while the flight is in progress.

The measurements received by the computer will be contaminated by various kinds of noise-refraction variations, antennae, servo-jitter, etc. The worst errors are caused by bending of the antennae in wind. To determine the orbit which best fits the noisy data, a weighted least-squares statistical method is used.

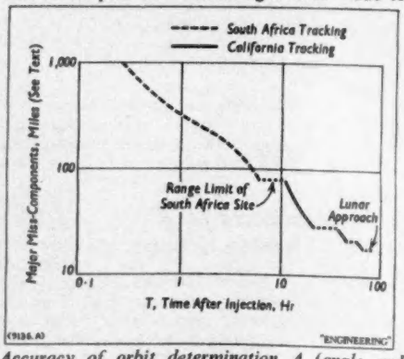
Calculations have been made to predict the precision of orbit determinations from the given radar sites, the required accuracy of radar tracking and the relative accuracy of different kinds of tracking. The graph on the right shows representative results for a 76 hr lunar trajectory in which the probe is injected over the South Atlantic and tracked first from the South Africa station and then from California. The contours of constant probability of dispersion are ellipses, and the semi-major axis of the ellipse containing 40 per cent of all cases is referred to as the *major miss-component*. The graph also shows in terms of this quantity the miss resulting at the Moon due to uncertainties in orbit determination, as a function of the time after injection at which a *perfect* midcourse correction is applied. The early tracking data have the strongest effect on the precision of the orbit calculations. If no radar tracking is available until 5 hr after injection, there is difficulty in applying the numerical procedures.



The left-hand graph shows how the magnitude of the necessary mid-course manoeuvre varies with the time of application for selected errors (one-at-a-time) in range and velocity components at injection. In practice, corrections would be applied 10-20 hr after injection on lunar missions and in the first few days of interplanetary journeys.

The techniques of radio command mid-course guidance which had been developed were suitable for ensuring impact on a small pre-selected area of the moon, for sending a recoverable probe round the moon and back to the earth, or for guidance prior to the establishment of a lunar satellite. If the Astronomical Unit could be measured more accurately, these techniques would ensure approaches of 10,000-20,000 miles to Mars or Venus.

Mr. D. J. Cashmore (English Electric Aviation Limited) spoke on the role of inertial equipment in the guidance of a lunar vehicle, but began by discussing the five points of equilibrium in the earth-moon system—the points at which the sum of the gravitational attractions of earth and moon plus the "centrifugal force" due to



Accuracy of orbit determination A (angle and range-rate data).

the system's rotation totals zero. The point between earth and moon on the line joining their centres was well known, but there are also two other equilibrium points on this line produced: one beyond the side of the moon away from the earth, and the other beyond the side of the earth away from the moon. At all three points the equilibrium is unstable, and a body slightly displaced from one of these points will continue to move away from it.

SPACE BEACONS

However, there are two other points of equilibrium one on each side of the earth-moon axis, and theoretically these are points of stable equilibrium. They are analogous to the points of equilibrium in the Jupiter-Sun system (small groups of " Trojan " planets precede and follow Jupiter in its orbit round the Sun). Mr. Cashmore suggested that when space technology had advanced further, it would be possible to place beacons at these positions; they could be simple buoys of the Echo balloon type, radio beacons, or rotating optical devices with alternate black and white surfaces, so as to appear as a rapidly varying star.

Inertial equipment (consisting of a gyro-stabilised platform carrying accelerometers, together with integrating devices to compute the velocity and position) will play a major role in the boost and injection phases of a lunar trip, as it does in the ballistic missiles of today. This equipment can also be used to monitor the execution of any mid-course manoeuvres that are found necessary. From the point of view of overall safety in manned expeditions, however, it is desirable to have independent navigation systems, to avoid total reliance on one.

A combined optical-inertial system is thought to be a suitable alternative to ground-based systems; it would have the advantage of increasing the operational flexibility. It is desirable that all the injection, mid-course and terminal guidance equipment should be integrated into a single overall system and for this purpose a lightweight flexible digital computer that can be carried on the vehicle will be required. Using transistors and printed circuits, this is quite feasible. The Verdan computer made by Autonetics (USA) is an example of what can be done; it includes a general-purpose computer and a digital differential analyser (capable of processing 128 variables every hundredth of a second) within a space of 1½ cu. ft.

In the final paper, Mr. P. A. E. Stewart discussed surface navigation on the Moon. It seemed unlikely that the Moon possessed a magnetic field or an effective ionosphere for radio communication. Its smaller diameter meant that there would be increased curvature and therefore a reduced line of sight compared with the Earth. New navigational techniques would therefore have to be developed for surface exploration of the Moon.

These would include the use of navigation satellites (although these are likely to be unstable if in close orbit, owing to the Earth's perturbation and the effect of the Moon's " bulge "), sighting rockets, ground current telegraphy and seismic shocks.

RATIONALISATION NEEDED

In the discussion, Dr. Porter of the Nautical Almanac Office (well-known to many for his regular broadcasts on the night sky) criticised the lack of uniformity in the treatment of the subject. There were astronomers, mathematicians, engineers and dreamers talking about it, and he wished they could all speak the same language and employ a unified system of units. He was shocked to find Dr. Noton had his *y*-axis vertical.

Dr. Porter also referred to what he considered to be shortcomings in inertial navigation. This involved having three telescopes locked on to three stars. It was pointed out that we would know only the apparent positions of the stars and they would be disturbed by aberration effects. There is an error of 10^{-5} *g* in the best accelerometers. While these effects would not be serious for a lunar journey they would be important in interplanetary voyages and could cause an error of 30,000 miles.

Mr. N. Roberson, an American astronautical consultant and a leading authority on attitude control of rockets said that the figure of 10^{-6} *g* was only true on Earth; accelerometers had been built which were accurate to 10^{-8} *g in space*. The language used would be that of the people who did the job—engineers.

Commander Hatfield of the Hydrographic Department, mentioned that the survey of Britain obtained optically by triangulation did not agree with that obtained electronically with satellites. The former measured distance and the latter time (then multiplied by the velocity of light). He wondered if there was some discrepancy between the optical and electronic universes. Dr. Porter added that the distances of the Moon and Venus obtained by radio methods were also different from the optically obtained data of the Nautical Almanac. No one present at the meetjng offered an acceptable explanation of the phenomenon.

X-Ray Measurement of Misorientation in Metals

When a polycrystalline metal is plastically strained, the resulting deformations may be a bending or tilting of the atomic lattice within the grains of the metal, known as misorientation. The United States National Bureau of Standards has recently developed an X-ray diffraction method for obtaining quantitative measurements of this deformation. Such data will be used in fundamental studies of the mechanical properties of metals.

The new method has so far been used to measure intragranular misorientation in cartridge brass specimens, The data indicate that some of the misorientation induced by plastic deformation in tension disappears after compression. Experimental results of this work will be used in research on metal fatigue.

The grains or crystallites of which an ordinary polycrystalline metal specimen is composed may become misoriented when very small amounts of plastic strain are applied. This misorientation has been qualitatively determined in studies of metal structure; but only a few quantitative measurements have ever been taken, and these required techniques of considerable complexity.

Preliminary studies showed that misorientation of several hundredths of a degree could be determined by means of a two-exposure photographic process. In this process, two patterns of spots obtained by X-ray diffraction from the grains in a specimen are photographed, one exposure being made while the specimen is oscillating and the film is stationary; the other, while both the film and the specimen are oscillating synchronously. The breadths of a large number of spots thus reproduced on the two films are then measured, and an average breadth for each film is calculated. From these data, a numerical value may be derived for average misorientation in the specimen.

To obtain such data, an instrument based on the design of a double-crystal spectrometer was constructed. In the first crystal position of the instrument is a stationary mount for a plane crystal monochromator; and in the second crystal position, a specimen mount that oscillates when driven by a small electric motor. A third essential part is a film holder that either remains stationary or oscillates synchronously with the specimen mount. This equipment, together with a collimator, is supported on an adjustable metal base.

One X-ray diffraction pattern is produced by directing an X-ray beam from a copper-target tube through the collimater on to a strongly diffracting single crystal of lithium fluoride in the first crystal mount. This crystal diffracts a narrow monochromatic beam through an angle on to the specimen under study in the second mount. The grains in the oscillating specimen diffract the beam through another angle on to the film, while the film holder is stationary, so that a pattern is obtained. The film is then replaced, and both specimen and film are oscillated while a second pattern is being obtained from the same specimen. Comparisons of the average breadth of the spots in the two patterns may then be made.

The specimens used in the present work were sections cut from rectangular bar specimens of brass that had previously been extended, extended and compressed, or extended and compressed and again extended, from 1 to 4 per cent cumulative strain. Three specimens were sectioned from the reduced area in each bar one cut parallel to the axis of loading, one perpendicular to the axis, and one cut at a 45° angle to the axis.

The various amounts of strain present, and the average misorientation found for the three sections of each bar specimen are shown in the table. Despite a considerable scatter in the data from which the averages were computed, the largest amounts of misorientation were always noted in the specimens that had been sectioned at a 45° angle to the loading axis. This result indicates that the lattice distortion of individual crystallites in a polycrystalline matrix is directly related to their orientation.

The decreased misorientation found after reversed strain in the present study may be useful in developing a theory on the reversibility of dislocations in crystallites undergoing small amounts of plastic deformation. One result of particular interest was the linear increase found in residual misorientation at zero net strain with cumulative strain. This phenomenon indicates a non-recoverable disorder which may be attributed to the capture of some dislocations at pinning points on the slip planes of a crystal.

TABLE:—*Results of Intragranular Misorientation Measurements in Brass*

State of plastic deformation			Average Misorientation, 1/100°			
			45° Section	Cross section	Longitudinal section	Condition average
Annealed initial condition			—	—	—	6
Cycle position	Net strain (per cent)	Cumulative strain (per cent)				
Positive cycle						
1/4 (E)	+1	1	33	27	23	28
1/2 (E-C)	0	2	13	12	10	12
3/4 (E-C-C)	−1	3	67	38	28	44
1 (E-C-C-E)	0	4	25	18	11	18
Negative cycle						
1/4 (C)	−1	1	32	18	28	26
1/2 (C-E)	0	2	18	9	15	14

E—Extended 1 per cent. C—Compressed 1 per cent.

Tunnel Effect Applied to Insulators

The recent invention of the tunnel diode opened new possibilities for electronic engineering—cheapness and compactness being the main points. A device with a much simpler configuration has now been discovered.

A RESEARCH discovery that yields original scientific concepts and may make possible a new family of electronic devices has been announced by the General Electric Company in the USA.

An electronic process known as "tunnelling," which has previously proved useful in carefully prepared semiconductor materials, has been observed for the first time in materials of simpler configuration. These devices consist of two metal films separated by a thin insulating layer, with one or both of the metals in the superconducting state (offering no resistance to the passage of electrical current).

This discovery, which was made by Dr. Ivar Giaever of the General Electric research laboratory, is adding to the fundamental knowledge of both the tunnelling and superconductivity phenomena, and has opened up a new approach to the construction of versatile microminiature electronic components. For example, it may be possible to make, in an entirely new way, a simple device that would function as a switch, diode, negative-resistance diode, triode, resistor or capacitor.

The use of the tunnelling phenomena in electronics has received considerable attention since the Japanese scientist, Esaki, first described the tunnel diode, some three years ago. However, tunnelling occurs in a broader class of materials than semiconductors. In Giaever's discovery, tunnelling occurs through the simple barrier of an insulating film, rather than through the charge depletion region of a semiconductor *p-n* junction, as is the case with the tunnel diode.

ATOM-LAYER INSULATORS

The tunnelling of electrons through thin insulating layers can be understood by thinking of the charge-carrying electrons not as particles, but as waves. When these charge-carrying waves strike a barrier (such as would be imposed by an insulating film), virtually all of them will be reflected back from the barrier. There is a certain small probability, however, that a portion of the waves will pass through the barrier if it is thin enough. If a conductor is present on the other side, the presence of these tunnelling waves may be detected as a current. Despite the small probability of waves tunnelling rather than reflecting, the number of waves is large enough to ensure that a substantial tunnelling current may flow.

Certain conditions must prevail for electron tunnelling to be significant. If two plates of metal are separated by a good insulator, they form a capacitor, or condenser. Current does not flow through the insulator, even if it is as thin as 0·0001 in. However, if the insulator is made much thinner, say from 10 to 100 atoms thick, the probability of electrons getting through the barrier becomes sufficient for a measurable current to flow. At relatively low voltages, the current induced by tunnelling is proportional to the voltage, just as it would be if the insulator were an ordinary resistance element. That is to say, as higher voltages are applied, the current increases.

In experimenting with tunnelling through ultra-thin insulating films, Giaever found an unexpected effect when one of the conducting films became a superconductor. Instead of a straight line graph showing the current to increase proportionally with increase in voltage, an S-curve was produced, indicating that an effect similar to that in the tunnel diode might be involved. Giaever then followed up this lead and found that a region of negative resistance (in which the current *decreases* with increase in voltage) could be observed if both metal films were in the superconducting state.

This effect is the result of the fact that certain energy levels in a superconductor are "forbidden" to electrons. Any electrons in one metal film that have energies equal to forbidden energies in the other metal film cannot tunnel through the intervening insulating film. Therefore these forbidden energy gaps in superconductors have a profound influence on the tunnelling current and lead to the unique behaviour discovered by Giaever. Similar regions of negative resistance have been discovered in tunnel diodes.

The differences between the curves shown in Fig. 3 indicate how the important property—the electron density of state—changes when a metal becomes a superconductor. It is hoped that experiments of this type will provide a means of observing and, later, understanding the effects of temperature variations on the influence of a magnetic field over a superconductor.

This unpredicted finding may have important implications for theories about superconductivity as well as tunnelling. From the practical standpoint, the discovery may become important by making possible a new family of devices unequalled for their small size and versatility.

Most of Giaever's experiments have been with films of aluminium, lead indium and tin, all of which become superconducting at near liquid helium temperature. A considerable number of other metals are expected to exhibit the same effect. In almost all of the experiments, aluminium oxide was the insulating layer, though tunnelling was also observed through tantalum oxide, niobium oxide, and nickel oxide.

MAGNETIC FIELD EFFECT

One of the primary advantages of any device incorporating this newly discovered effect is the possibility of changing the device's characteristics with a magnetic field. This is the result of a well established property of superconductors, i.e., they can be changed to the normal state (non-superconducting) by the application of a strong magnetic field. Thus, by varying a magnetic field, one or both of the superconducting films can be changed to the normal state, with a consequent change in the operating characteristics of the device. Hence the device may be operated in many differing ways.

Other potential advantages of a device based on the new effect would be extremely small size, low power requirements, and cheapness of manufacture. Since the devices would be made simply be depositing metal and insulating layers on a suitable substrate, it would be possible to deposit complex circuits involving hundreds of active components in one operation. This would result in a very large reduction in cost from present methods of fabricating and assembling complex circuits, and would make possible a comparable reduction in size. The low power dissipation—with only a small amount of heat generated—would make it possible to package the microminiature elements at a density many times greater than in semiconductor components.

A great deal of applied research and development will be required to evolve practical devices based on the new concept. Furthermore, the requirement for cryogenic temperatures for the suggested new components may be a handicap. However, this is not expected to be a serious disadvantage for many of the potential users. Small liquid helium refrigerators are available nowadays and, in general, cryogenic technology is growing very rapidly.

The discovery of these new and unsuspected effects is making an important contribution to fundamental scientific knowledge of both superconductivity and tunnelling. One of the basic problems of superconductivity is why some metals are superconductors and others are not. The experiments that Giaever has designed are contributing data that may prove useful in solving this problem. Moreover, solid-state physicists will now find it necessary to develop the theory of electron tunnelling beyond the previous state of understanding—which was sufficient to explain the tunnel diode phenomena—in order to explain fully these new results.

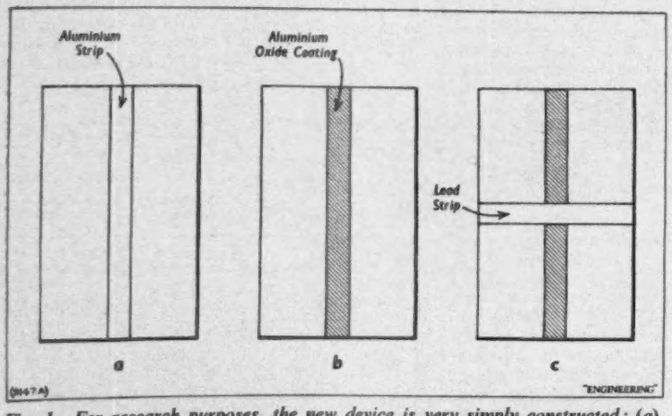


Fig. 1 For research purposes, the new device is very simply constructed: (a) a strip of aluminium is evaporated on to a glass slide, (b) the strip is oxidised, (c) a strip of lead is then evaporated across the aluminium, sandwiching the oxide film between the two metal strips.

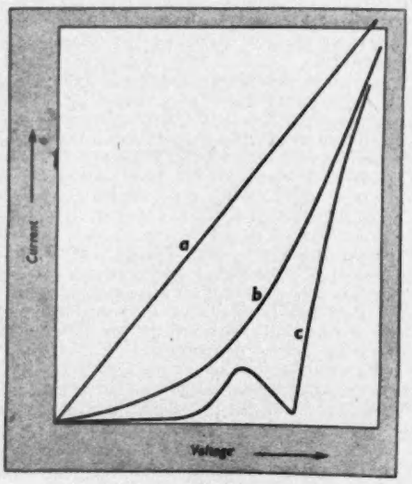
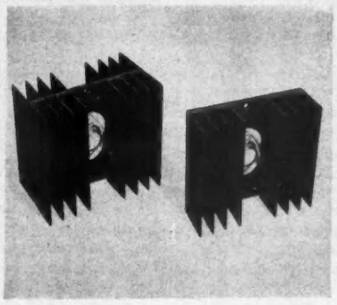


Fig. 2 (Right) Three possible voltage/current characteristics for the tunnelling current can be obtained: (a) between two normal metals, (b) between one normal metal and one superconductor, [and (c) between two superconductors, showing negative resistance.

Heat Sinks Cooled by Natural Convection

Increasingly wide use of power transistors and related semi-conductor devices in the many fields of electronic engineering has made necessary the provision of effective but inexpensive means of cooling.



Cooled by natural air convection.

To cater for this need, Marston Excelsior Limited, Fordhouses, Wolverhampton, Staffordshire, whose work for the electronics industry has been concentrated on specialised heat exchangers for airborne equipment, have now designed standard heat sinks cooled by natural air convection. Limited quantities of two models are now available. Model 1 with 16 fins has a nominal thermal resistance of 1¾° C per watt and model 2 with eight fins, 2½° C per watt in free air.

These coolers have been extensively tested under a variety of conditions and the manufacturers will supply performance figures and specifications on request.

Compact Insulators for High Voltages

What is claimed to be an entirely new form of construction for high-voltage post insulators has been announced by Doulton Industrial Porcelains Limited, Wilnecote Works, Nr. Tamworth, Staffordshire.

The product of Doulton's research and that of Merlin-Gerin of Grenoble in France, has resulted in what is known as the Doulton Multicone Post Insulator, which is an aid to overcoming many of the problems associated with the increasingly high voltages of the world's grid systems.

System voltages have now reached 380 kV and even higher voltages of up to 700 kV are contemplated. At these voltages the design of suitable insulating columns or pillars for equipment such as disconnecting switches becomes increasingly complex if conventional methods are used.

The normal support insulator for 275 kV already reaches 10 ft in height and the space required for substations at these very high voltages is a growing embarrassment to supply engineers, not only for the outdoor construction but also for the indoor or protected substations which are now being specified for some coastal areas.

The Multicone insulator represents a considerable advance towards solving these problems. The porcelain elements are in the form of cones fitting one inside the other and bonded by cement joints. There is therefore no internal creepage path which can be broken down.

The puncture path is through many layers of porcelain and the voltage required to break down this path is so high, compared with the external flashover value, that nothing approaching it can be maintained.

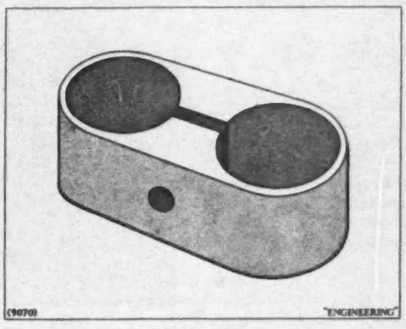
Difficulty is normally experienced in obtaining low deflection figures at cantilever loadings with the normal pedestal post assembly, due to the fact that the main loading parts are metal at relatively small diameters. As an example, a 275 kV post designed to meet normal BS requirements, needs fourteen metal components in addition to the top and bottom fixing flanges. The equivalent Multicone post uses only two. As a result, the deflection of the post is less than a third of a conventional post.

As the Multicone is designed without internal air spaces, the problem of sealing against the ingress of moisture is avoided.

Other advantages which the makers say are inherent in the design are: reduced height, reduced diameter, high impulse levels and a long leakage path. Flexibility is offered to the designer as it is possible to vary the characteristics of a post by the choice of the number of conical elements which are included in the assembly.

Simple Anti-Vibration Mounting

An efficient, cheap and compact anti-vibration mounting for electrical components such as electromechanical uniselectors has been developed by Automatic Telephone and Electric Co. Ltd, Strowger Works, Liverpool 7. The mounting consists of a flexible electrically insulating plastic moulding (such as nylon) having parallel sides and semi-circular ends; each side having a central portion extending inwards and a hole for a mounting screw.



An efficient, cheap and compact unit.

Two such mountings would be used to secure a uniselector to the parallel rails of an apparatus rack; and it is claimed the cost of installation would be much less than that incurred using any other conventional method.

Range of Small High-Speed Turbines

An extension to the range of small turbines manufactured by the Westinghouse Electric Corporation, Pittsburg, Pennsylvania, has been introduced to include high-speed multi-stage units. The new turbines are available in five frame sizes and are rated to 32,000 h.p. and 16,000 r.p.m.

Maximum steam conditions of 1,500 lb per sq. in and 950° F apply to all sizes, but conditions of 2,400 lb per sq. in and 1,050° F can be accommodated for special applications. Exhaust pressures can be as low as 1 in of mercury or as high as 300 lb per sq. in on most sizes.

As many stages as are needed can be built into the turbines with any of five wheel diameters from 12 to 32 in.

Cooling Aircraft Cabins on the Ground

An unusual use for Perkins P6 diesel engines is being found by applying them for cooling aircraft cabins while on the ground.

The engines drive two Godfrey/SRM screw-type compressors (see ENGNG., 25 Nov., '60). which supply air to air conditioning trolleys at controlled temperature and pressure for aircraft cabins and electronic equipment. The air is also used for ventilating the pressurised suits of crews of military aircraft before take-off.

Air delivered from one compressor circulates through heat exchangers and a water extractor to four selected outlets. The other compressor draws air through a sucking turbine, where its temperature is reduced, passing to a heat exchanger where it cools the cross flow of air passing to the delivery outlets.

Cable-Laying Ship for Deep-Sea Work

Specifications and plans for a new cable-laying ship have been put out to a number of British shipyards by Cable and Wireless Limited, Theobalds Road, London, WC1, for the receipt of tenders. The ship, which will be of about 8,000 tons, has been designed to lay and handle modern types of deep sea communication cables and repeaters, including the kind to be used in the 28,000 mile Commonwealth round-the-world telephone cable.

When the ship is completed in 1962, it will be the first cable layer to have been owned by the company, and will also be the biggest and fastest ship in their fleet of seven vessels.

With diesel electric propulsion, it will have a trial speed of 16 knots with a steaming range of 8,000 miles and a sea endurance of 60 days. Its carrying capacity will be 1,200 miles of lightweight telephone cable with repeaters, or 1,500 miles of conventional telegraph cable. Fully air-conditioned, it will be able to work in tropical waters as well as colder climates.

A new 4,000 ton cable-repair ship is at present being built for the same company and is nearing completion in the shipyards of Cammell Laird and Company (Shipbuilders and Engineers) Limited, at Birkenhead. This ship—which will have a maximum speed of 15 knots—is due to join Cable and Wireless's fleet in April of 1961.

Loudspeaker for Transistor Receivers

To enable the overall depth to be reduced to a minimum, the magnetic circuit in a new 2½ in diameter loudspeaker uses an unusual constructional technique. A rod magnet is inserted into a split aluminium ring which is fitted into an accurately machined yoke. This design is claimed to give a compact, robust motor unit

Loudspeaker has a depth of 0·83 in.

⅛ in diameter without magnet assembly bolts.

Made by the Plessey Company Limited, Ilford, Essex, the loudspeaker is designed for use in miniature transistorised receivers and is available with a low impedance voice coil (8 to 10 ohms) for use with a matching transformer or alternatively with high impedance coils for direct connection into transistor circuits.

Engineering Serves the Farmer Well

Smithfield Show without any live animals was a sad sight but the display of farm machinery was more comprehensive than ever before.

PRIDE of place in any agricultural machinery show seems always to go to the tractor because it is such a basic tool in any modern farming community. It also takes first prize in the farm machinery export figures, accounting for about 67 per cent of this year's present total. In spite of the general depression in the motor industry, tractor production on present records is actually up on last year's figures.

The first public showing of a new range of tractors was given at the recently held Royal Smithfield Show and Agricultural Machinery Exhibition by the Ford Motor Company in displaying their new Fordson Super Major. Introduced in 1951, the Major was immediately accepted by the farming community all over the world, and the Super Major has built into it the experience gained from these years of operation.

"Qualitrol"—a feature which the Fordson Dexta previously possessed—is now fitted to the Super Major. It gives effective depth control by implement draught. This enables work to be completed under constantly changing soil conditions and contours which normally invoke loss of wheel grip and the continual manipulation of controls and gear changing. Qualitrol, as fitted to the Super Major, has the addition of a flow control valve, thereby enabling the driver to alter the rate of oil flow in order to suit variable working conditions.

Position control on the Super Major enables an implement to be automatically maintained in its relative position to the tractor, irrespective of changes in soil resistance. With Qualitrol and Position Control, a better transfer of weight from the implement to the tractor is given, thus increasing rear-wheel adhesion and consequent pull.

A differential lock is fitted which enables the driver to cut out the differential action of the rear axle shafts, thereby obtaining the effect of the combined pull of both wheels. Disc brakes are also fitted and it is claimed that these are equally effective in either direction of rotation.

Driver comfort is increased, and the front-end of the tractor has been restyled to give a neater appearance. The Dexta has also been provided with a new look, and for overseas buyers there is the alternative of fitting to it a petrol engine of 2,188 c.c.

To the David Brown 850 and 950 Implematic diesel tractors comes the option of fitting an exhaust brake; it can also be fitted to those already in service. Control is effected through linkage to a spring-loaded clapper-type valve located between the exhaust manifold and the exhaust pipe itself.

To bring the exhaust brake into operation, the governor control is first moved to the closed position and pressure is applied with the foot to the exhaust brake pedal above the clutch pedal. This closes the clapper-valve and builds up a controlled back pressure in the combustion chambers, enabling immediate use to be made of engine compression to reduce speed. The footbrakes need only be applied if it is required to bring the tractor to a stop.

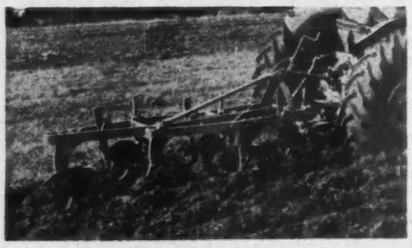
Apart from increased safety, this auxiliary braking power has obvious advantages in retarding heavy trailer loads on steep or slippery land and in general transport work.

David Brown Tractors Limited have also introduced a new front-end loader on which bucket and manure forks are easily interchangeable.

With the announcement of five new mounted ploughs, Ransomes Sims and Jeffries Limited, Ipswich, bring the number of their FR implements available for the new Fordson Super Major to over 30. Like the other FR ploughs they can be quickly set for alternative ploughing widths by moving one or more of the legs to the other side of the beam. The headstock frame provides for two lateral positions for the upper tractor link, a feature which allows the plough to be kept closely aligned to the true line of draught irrespective of the width of furrow for which the plough is set. It is often possible to plough in a economical gear.

(Right) The Fordson Super Major tractor has been created to provide maximum output, maximum safety and minimum driver fatigue.

(Below) This is one of the five new Ransomes FR Super ploughs designed with the Fordson Super Major tractor in view.



BSA say that their new 120 c.c. ohv engine can have a complete top overhaul in under 15 minutes.

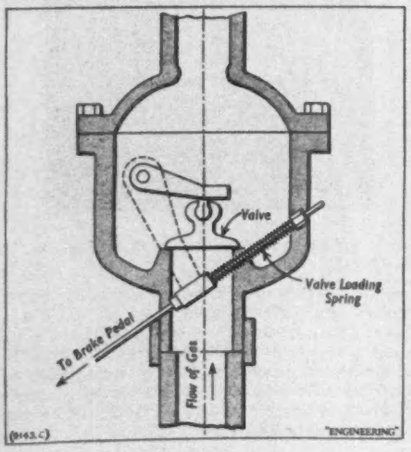
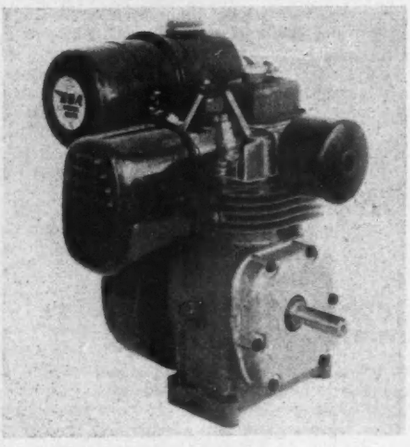


Diagram of the David Brown tractor exhaust brake. The valve is shown in the closed position. By a valve loading spring, a controlled back pressure is maintained when the brake is applied.



In the horticultural field the Gardenmaster range of rotary cultivators made by Landmaster Limited, Hucknall, Nottingham, has been added to by introducing two new machines, the Gardenmaster 85 and the 95. The first of these has a 3 h.p. 4 stroke engine, is of tubular frame construction, and has a rotary tool head, fitted with 12 in width of cut hoe blades. The 95 is designed for the garden owner and 18 in width of cut slasher blades with a hood are included.

Wolseley Engineering Ltd. of Witton, Birmingham 6, have a 14 in saw bench which is fully mobile and can be used with or without a truck. The saw bench, which fits on to the top of, and takes its drive from their Merry Tiller cultivator, has a tubular stand which ensures maximum rigidity while sawing, and can be turned out of the way for transporting. The saw table is adjustable so that the back of the table is clear of the Merry Tiller handles when it is used for ripping.

Among the power units which can be applied to agricultural purposes is one by BSA Power Unit Division, Redditch, Worcestershire. It is a 4-stroke 120 c.c. ohv engine, developing 3·2 b.h.p. at 3,600 r.p.m. The power-to-weight ratio of this engine has been improved by 73 per cent compared with the BSA side-valve engine of equal capacity, without sacrificing long life. The makers claim that, owing to the ohv design, a complete top overhaul can be carried out in less than 15 minutes. This can often be done without dismantling the engine from the equipment to which it is fitted. Several versions of the engine are available.

An important addition to the Perkins agricultural range of diesel engines is the 6 cylinder,

107 b.h.p. Six 354. It is specially suitable for heavy wheeled and crawler tractors and for large self-propelled combine harvesters.

Comparatively small and compact for its power output, the engine develops a maximum torque of 266 lb-ft at 1,300 r.p.m. The combustion chambers are toroidal bowls in the top of the pistons and fuel is injected directly into the cylinders through multi-hole atomisers.

In our issue of 20 May this year we described the Lucas Hydrostatic transmission system. Major tractor manufacturers are working in conjunction with Lucas Industrial Equipment Limited of The Radley's, Birmingham 33, who have fitted these systems to experimental models. Hydraulic drives are suitable for both wheeled and tracked vehicles and give complete control in awkward situations, such as negotiating sharp descents under load. In the event of marshy conditions, one driving wheel may be retarded hydraulically and all the tractive effort applied to the wheel on firm ground.

Simms Motor Units Limited, Oak Lane, London, N2, have just introduced seven new items of equipment. Among them, is a 4½ in diameter concentric-type electric starter motor. Unlike the "crash" type of starter, where the pinion is engaged by its own inertia and is thrown against the flywheel, the pinion on this new starter is engaged gently while rotating slowly and, will do the work for which a 5 in starter was previously required.

Available for high-speed diesel engines of up to 400 b.h.p., is a new turbocharger made by CAV Limited, London, W3. With a properly matched turbocharger, engine torque may be increased by as much as 60 per cent, while fuel savings of up to 12 per cent can also be obtained. When the engine operates at altitude, the turbocharger will automatically deliver the same weight of air as at sea level, so that it is not necessary to derate engines at altitudes below 3,000 m. Simple to install, the turbine and compressor casing flanges are available in a variety of angular settings to cater for individual requirements. The turbine and compressor are of the radial-flow type and are housed in casings which give a unit having minimum size and weight.

The Industrial Division of Dowty-Rotol Limited, Gloucester, have a range of turbochargers for diesel engined tractors up to 100 h.p. Special Dowty-Rotol plain bearings are incorporated, which are lubricated from the main engine oil supply, the drain oil being piped straight back to the sump.

To assist farmers in choosing the best electrical grain drying equipment for their particular needs, the Electrical Development Association, 2 Savoy Hill, London, WC2, organised a display at Smithfield which included the drying of grain in sack or in bulk, the drying of grass loose or in bale, and dual purpose dryers for both grain and grass. One shown was the Coypu grain protector made by North and Kinsman, Kings Lynn, Norfolk, which provides audible and visible warning of overheating in stored grain.

Wolseley Engineering's 14 in sawbench is fully mobile and can be used with or without the truck. The saw bench fits on to, and is driven by, a Merry Tiller cultivator made by the same firm.

High Pressure Reducing Valve for 4,000 lb per sq. in

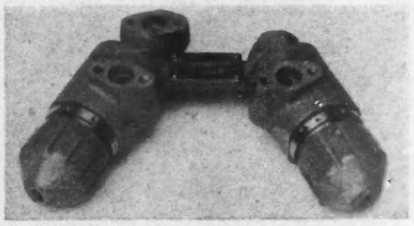
Capable of an extremely fast response rate with a high degree of stability under difficult conditions, a new high-pressure reducing valve made by the Hymatic Engineering Company Limited, Redditch, Worcs, is designed to operate without servicing for periods of up to 5 years.

Known as the PAS227, it has an inlet pressure range of 500 to 4,000 lb per sq. in, while the outlet pressure is 400 lb per sq. in ± 25 lb per sq. in over a flow range of 5 to 65 c.f.m.

The specification for which the valve was designed, demanded a downstream system in which the supply consisted of a few cubic inches only, and as a result, the limitation of overshoot and operation without oscillation which were essential requirements presented a difficulty.

The valve in its final form can accept an increase of pressure on the inlet side from 0 to 4,000 lb per sq. in in 2 milli-secs, control of the pressure in the downstream system consisting of 8 in of ¼ od pipe plus 3 cu. in and stabilises in 0·2 secs. The total overshoot of pressure downstream is less than 140 lb per sq. in above the control pressure.

Temperature range is from −58° to 110° C. It is claimed that accelerations of up to 20*g* can be applied in the most sensitive plane without affecting the outlet pressure characteristics. An integral filter is embodied and the valve measures 4¾ in long by 1½ in diameter.



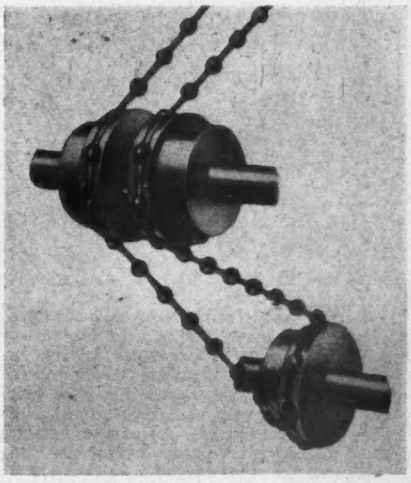
Two of the reducing valves mounted in a common housing for two separate systems.

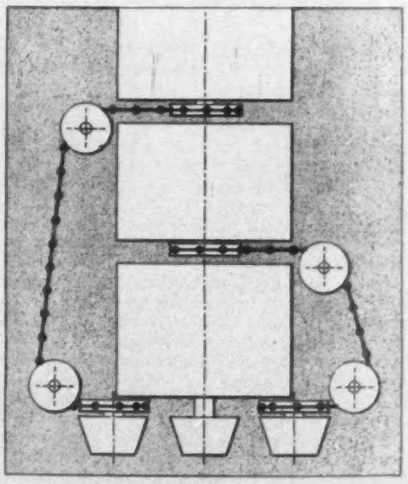
Flexible Drive by Ball and String

A new element of construction for use in instruments, and small machines is the Visomag flexible drive. It consists of strings made of a tough and practically stretch-proof material around which is braided a protective layer of special polyamid fibre to prevent wear and tear. On to these strings, balls are injection moulded during manufacture. These balls fit into hemispherical sockets in appropriate pulley grooves, so providing accurate, slip-free transmission.

Visomag strings not only obviate the use of complicated gearing systems, but in the case of operating non-parallel shafts they can be led around corners by guide pulleys. The flexibility of the strings allows the use of very small pulleys and as the usable length is more or less unlimited, a number of instruments can be actuated or controlled by a single string. Economy of space is another advantage, and in use, the strings are claimed to be practically noiseless.

String diameters of 0·5, 1·0 and 1·5 mm are usually suitable for use in instruments and apparatus, but thicker strings can be provided for applications involving greater strains. Where the movement of the strings is limited to a back and forward motion, balls are only needed on the operative sections. Special strings for transporting perforated paper or film strips can be had, fitted with tooth-shaped pieces instead of balls. Small parts can be transported by fitting hooks. Strings for power transmission are also available. Slip-free drive, absence of belt tension or power-absorbing gears ensure maximum efficiency from economical power output.





A typical example of Visomag ball strings is shown on the left. On the right, a deeply stepped arrangement of instrument pulleys is shown.

The makers, Viso Limited, of Switzerland, are represented in the UK by Ingliss Knibb and Co, of 20-21, Tooks Court, London, EC4.

Kitchen Range

THE JOB that is usually left to the last in the washing-up is also often the worst—the saucepans. A row of gleaming pans on the shelf represents a might of elbow grease and not infrequently some sore fingers. None of the standard dish-washing machines will do more than remove loose debris from a saucepan, leaving the baked-on layer still all too firmly in place.

Accordingly, there would seem to be a wide field for the Moulinex "Robot Marie," claimed to be the first electric pot scourer on the market. The scouring head is made of hard nylon with flexible teeth, which, it is said, will reach all corners of a pot or pan. It is also claimed that the nylon is soft enough to avoid damaging even fine aluminium, but strong enough to remove burnt food from baking tins.

Like most machines nowadays, the Robot Marie has a range of attachments designed to enable it to be used for several purposes. Examples of these are shown in the first illustration on this page. The scourer can be replaced by a mixer for sauces or omelets; a masher for vegetables; or a pastry mixer. The mixing bowl is included in the standard set. The makers claim that the equipment is easily dismantled and easily cleaned—two important points, because the time and labour of setting up and putting away equipment can often more than

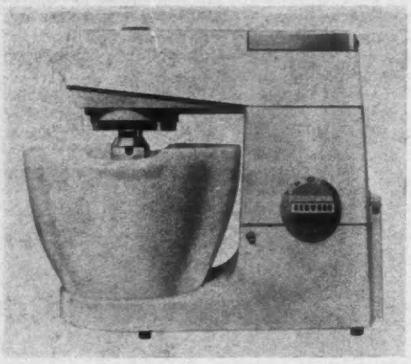
offset its usefulness. Replacements for the scouring head, the only item liable to wear, are cheap. Moulinex also produce a standard beater/mixer unit with three alternative blades, and a mincer and grater set with four drums that enable it to slice potatoes, grate cheese, and shred carrots as well as mince meat.

A well-tried mixer now appearing in a new styling is the Kenwood "Chef," shown in the second illustration on this page. The original model was launched in 1948 and the new one does the same work but is lighter in weight, as a different alloy has been used for its construction and, in addition, it has a spring to assist in the lifting of the head clear of the bowl. Another point in its favour is that its smoother appearance is more in accord with modern styling and is easier to keep clean.

The Chef is supplied only with glass bowl, whisk, "K" beater, dough hook and plastic spatula, but has no fewer than fifteen attachments that can be obtained as extras. These include a mincer, coffee mill, juice separator (two models) and a bean slicer. Unusual attachments are a can opener (with a magnet attached for holding the cut-away lid), and a sausage filler for use with the mincer. Anyone, therefore, who possesses the whole range should be able to perform almost any job of food preparation "under power."

Kenwood also manufacture a "Minor" mixing unit which can be held in the hand and hung up on a hook when not in use. The third illustration shows the *de luxe* version of this unit, with the stand and bowl that can be supplied for it. In such a form, it represents a machine for the smaller home, where the size of the Chef is not needed and where a mixer is only used at intervals, not as the regular course of events for most meals. There are no alternative attachments for the Minor.

Another item in the Kenwood range is an electrically-powered knife and scissors sharpener. Shaped like a domestic iron, the sharpener can be used for all sizes and forms of knife and it is



(*Above*) *Mixing, grinding and mincing are possible on the Chef, which has 15 attachments.*

(*Left*) *The "Robot Marie" is primarily an electric pot scourer with mixing attachments.*

(*Below*) *Smaller mixes can be done with the Minor, which is a hand-held tool with an optional stand.*

claimed that the design prevents any possibility of damaging the blade.

Two other kitchen machines are now being produced by Kenwood. They are the Dishmaster dishwasher and the Wastemaster garbage-disposal unit. The latter is designed to fit under the sink and will grind up any shells, peel or small bones to a size small enough to pass out through the normal waste system. It is one of the solutions to the garbage-disposal problem now being encountered in so many houses.

The Dishmaster is a high-speed machine; the commercial model having capacity for 600 pieces of china plus cutlery per hour. A water heater is included, controlled to 180° F. A good point about this machine is that the water consumption is low; only one gallon is required to wash and one to rinse for each loading of the machine.

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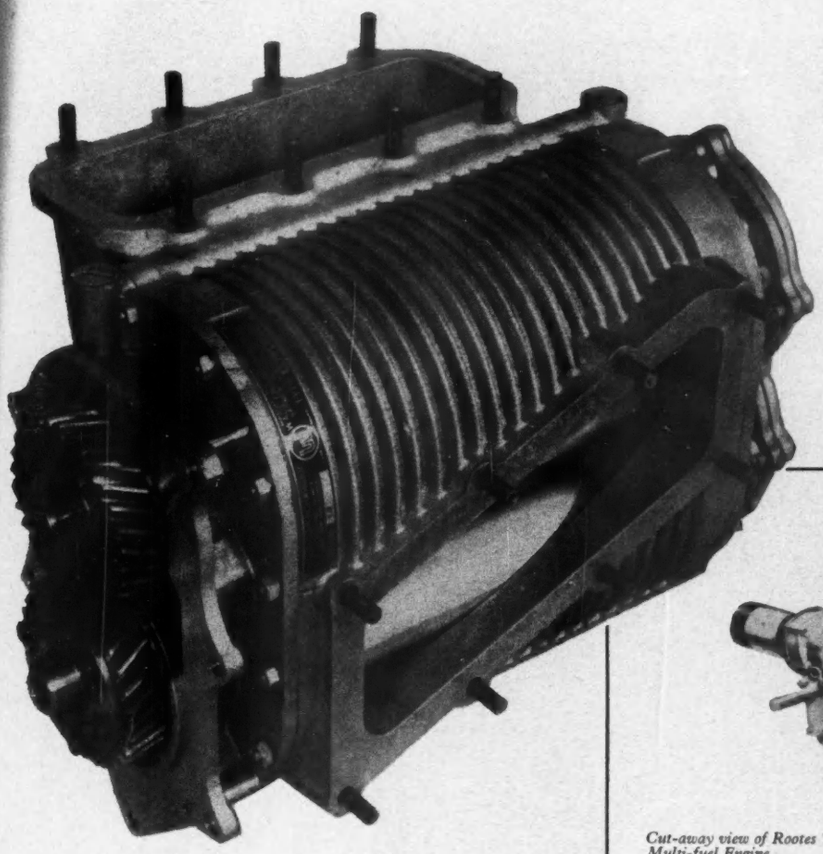

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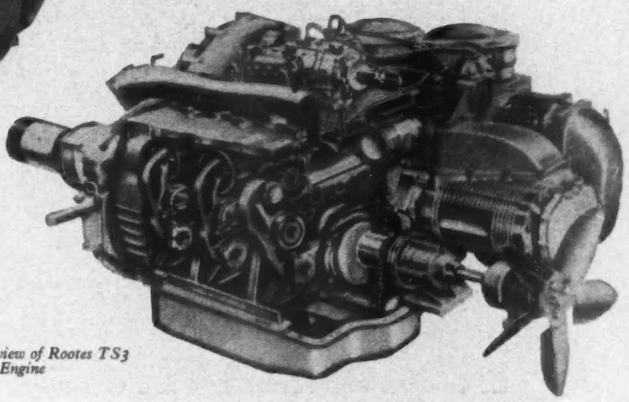

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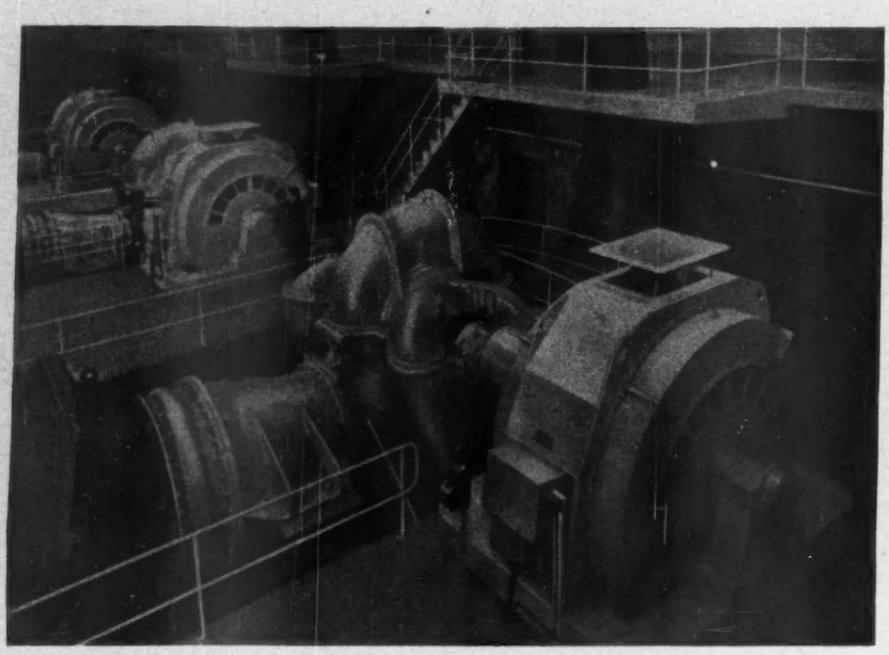

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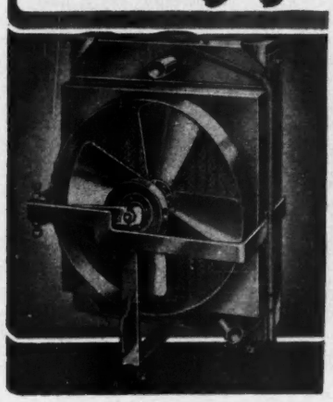

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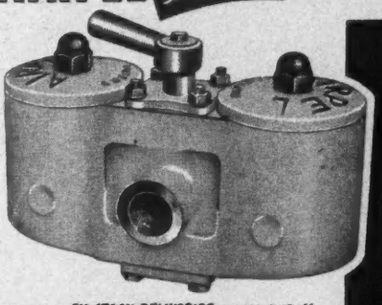

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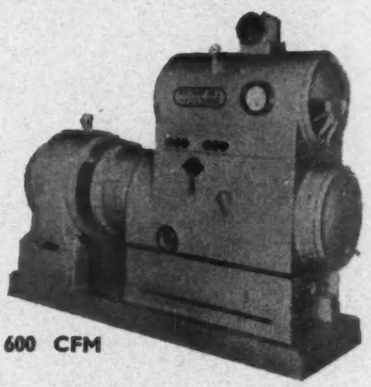

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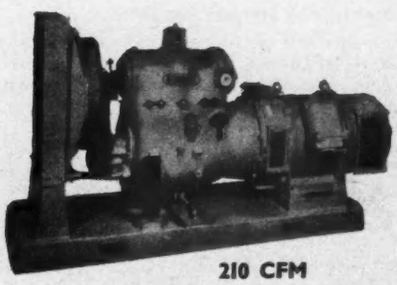

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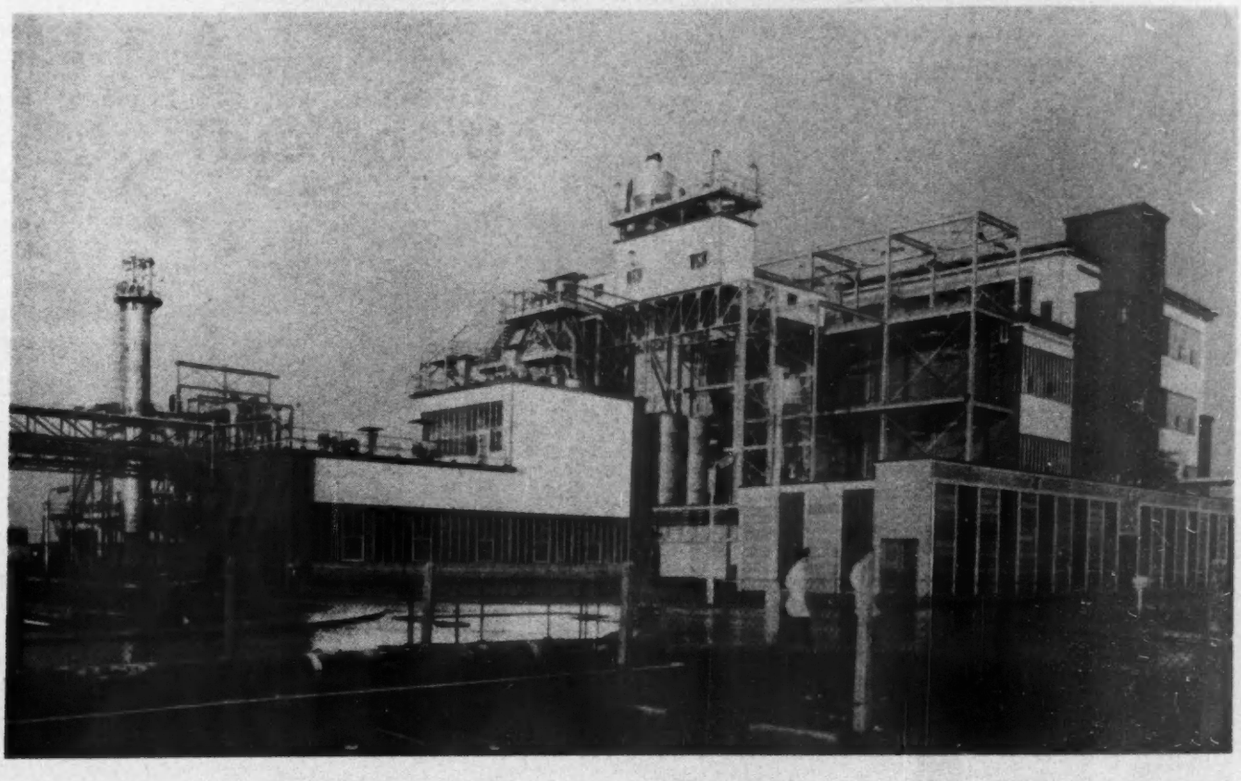

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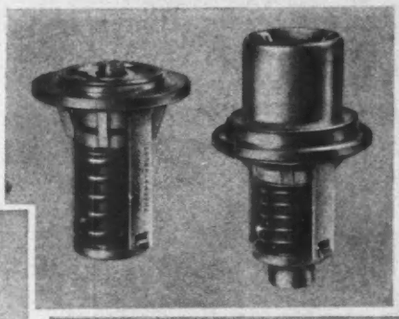

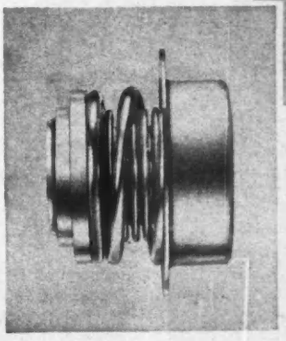

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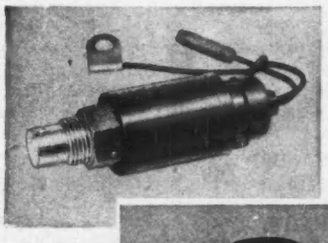

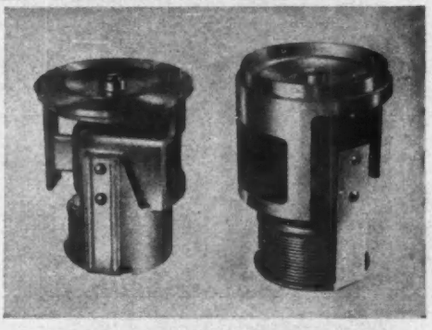

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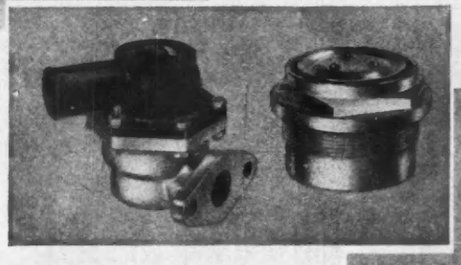

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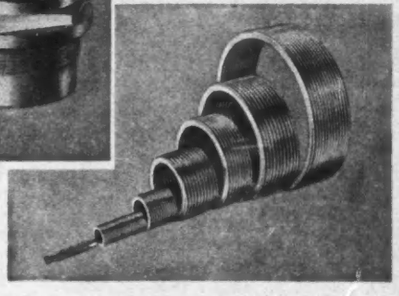

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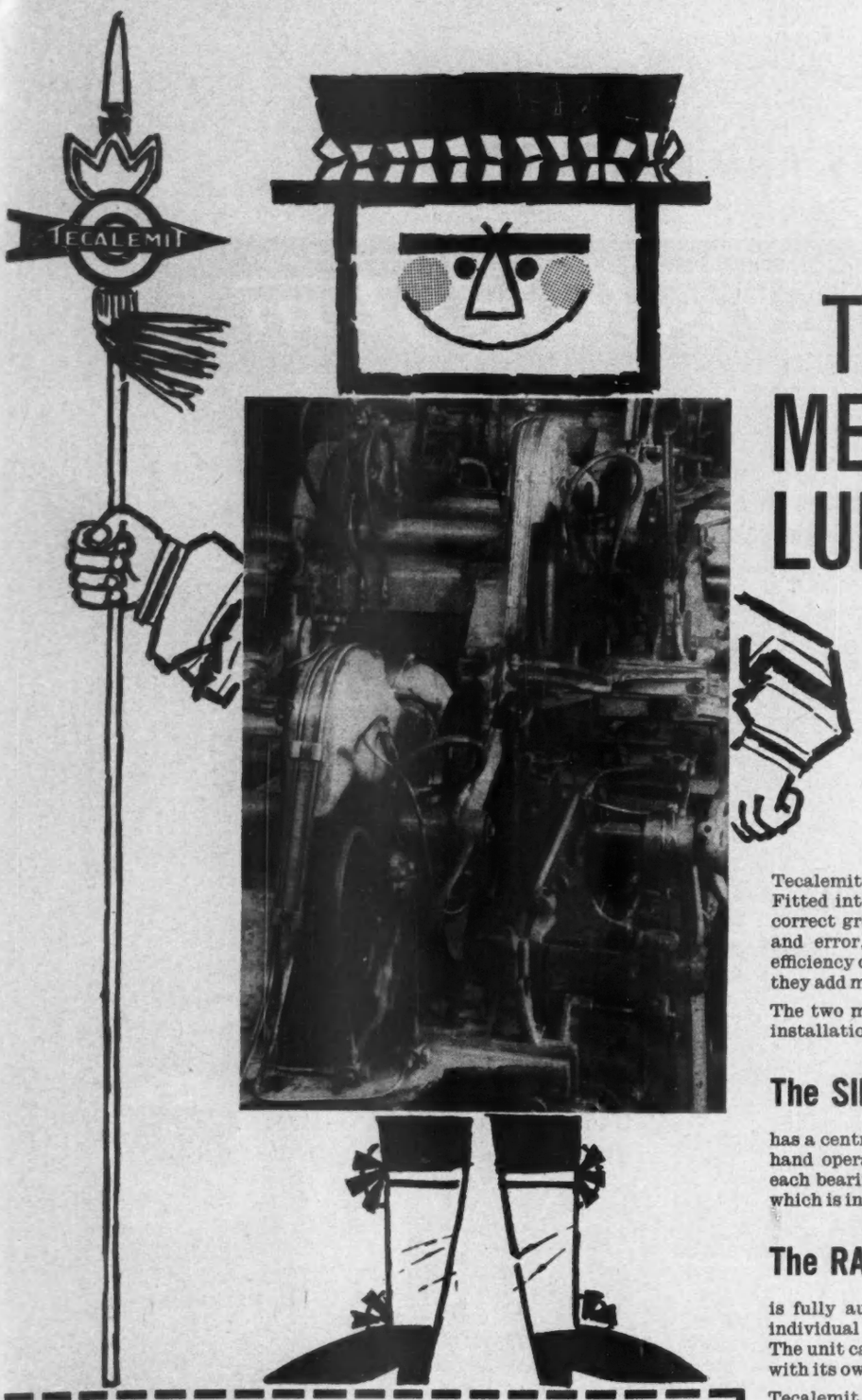

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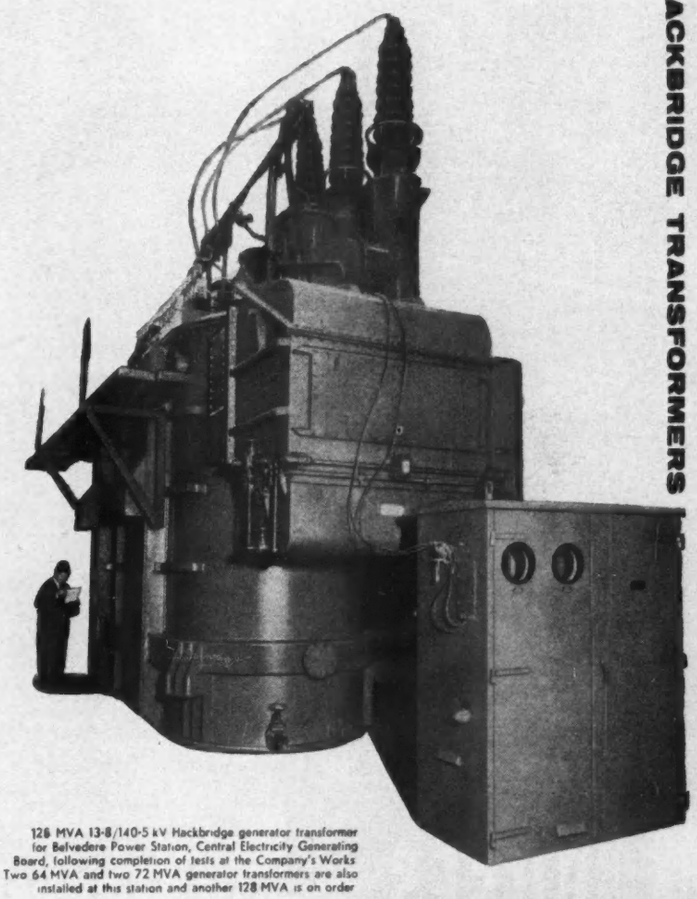

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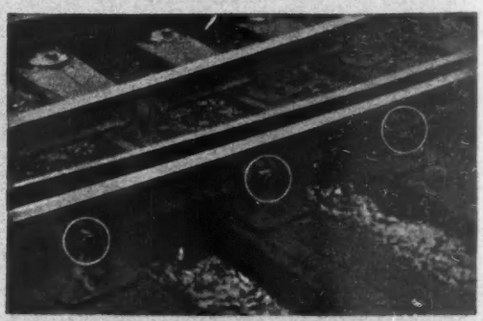

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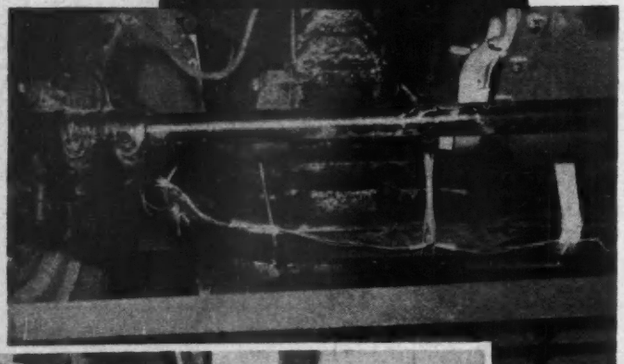

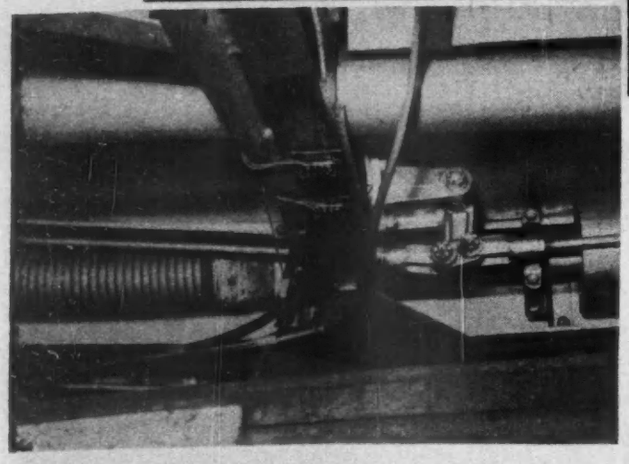

Bristol Commercial Vehicles, when modifying their 'Lodekka' to their "Flat Floor Lodekka" chassis, required to check design load figures.

Saunders-Roe Strain Gauge Engineers were commissioned to install foil strain gauges, supply recording gear and take part in dynamic tests. The road trials included violent manoeuvres to cover the most stringent service conditions. From the results, the design engineers confirmed their calculations.

Saunders-Roe have also been commissioned to carry out similar strain gauge tests on the Eastern Coach Works "Flat Floor" Lodekka body.

*Every day throughout Industry, Saunders-Roe Foil Strain Gauges are doing similar work. Their excellent properties, electrical and mechanical, give great flexibility of operation. They can be intimately bonded to the test structure, even in awkward places and on sharp contours. They need only simple electrical measuring apparatus. There is a range of types and sizes to suit almost any material and a wide span of working temperatures.

Our field service organisation is ready to give advice, install gauges and instrumentation, and also conduct tests from start to finish.

*In addition, Saunders-Roe now market metalfilm strain gauges (covered by Saunders-Roe's U.K. Patents), and photo-stress material, gauges and instruments as sole U.K. Agents of Budd S. A. (a subsidiary of the Budd Company, Philadelphia).

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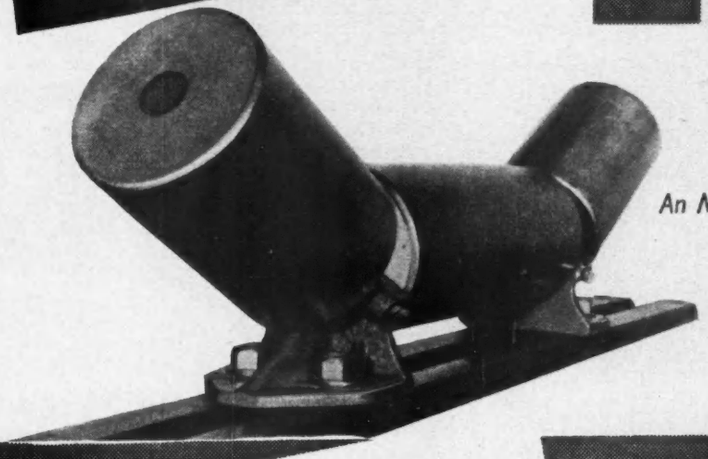

An M&C idler for a 24-in. conveyor belt.

To say that idlers are "sealed for life" is an empty phrase, for how long is "life?" A butterfly's life or an elephant's? M&C idlers are sealed for long life. Put to work as delivered and left to themselves, they will be in the best of health long after others have given up. And M&C seals can be rejuvenated at intervals, new grease driving out the old, making the seals perpetual and multiplying the life of the idlers many-fold.

EXAMPLE WITHOUT MAINTENANCE

1950, the belt conveyor idlers sealed for their first life.
By arrangement, the grease gun was not used.
1959, still going strong.

EXAMPLE WITH MAINTENANCE

1943, sealed for first life.
Three-shift running.
Resealed by grease gun at intervals.
1959, aged 16 years, still going strong.
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Stress Relieving Large Vessels without a Permanent Furnace.

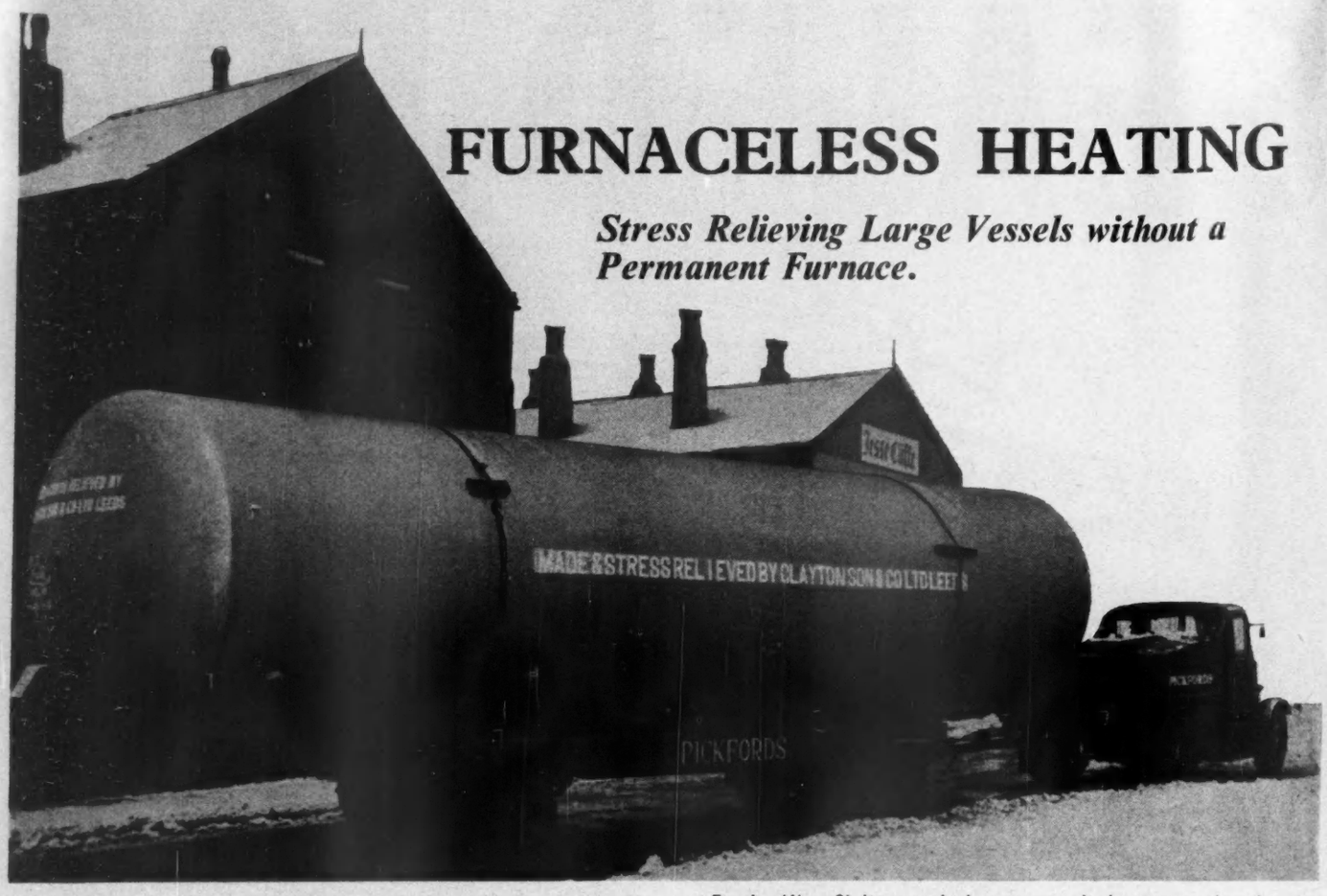

Fig. 1. 46′ × 9′ diameter high pressure cylinder, stress relieved *in situ*.

Clayton Son & Co. Ltd., of Leeds, have been well known as heavy engineers for nearly 100 years and one important aspect of their business is the fabrication of large welded pressure vessels. Recently they received an order for two high pressure propane gas cylinders, one of which is shown in Figure 1. These are of all-welded construction and to comply with British Standard 1500, dealing with stress relieving of pressure vessels after welding, the whole of the vessel must be heated after fabrication according to an extremely exact time/temperature schedule. When the stress relieving temperature of the vessel is at 650°C, the temperature differential between any two points must not exceed 50°C.

The usual method of meeting these requirements is to place the pressure vessel in a gas-heated furnace and raise its temperature in accordance with the requirements of B.S. 1500. However, as the dimensions of the vessels increased—the gas cylinders mentioned above being 46′ x 9′ in diameter—the number of stress relieving furnaces available for this class of work was limited. Sometimes the job had to be done by inserting one end of the container into the furnace with the other end protruding, and then reversing it. This was obviously uneconomical in terms of fuel and hardly met the real requirements of B.S. 1500.

Messrs. Claytons discussed their problem with the Industrial Development Centre of the North Eastern Gas Board, and they undertook experiments with high velocity jet type gas burners, working on an old Lancashire boiler shell. Within six months, the North Eastern Gas Board had evolved a method of stress relieving these larger containers *in situ*, obviating the inconvenience and expense of transporting the vessel to another factory for the stress relieving to be carried out. This stress relieving process is covered by a joint patent held by the North Eastern Gas Board and Clayton Son & Co. Ltd.

A model of the equipment used is shown in Figure 3 and the burner is shown in Figure 2.

First the whole of the vessel was lagged with an insulating material which in this case was 4″ of Rocksil. The jet burner was then arranged to fire through the manhole of the vessel into a hot gas distribution tube arranged internally, having a number of perforations, as shown in Figure 4. The hot blast of gas through the central distribution tube causes, by entrainment, the recirculation of waste gases within the centre tube, distributing the heat uniformly throughout the vessel. In addition, arrangements were made for jets of compressed air to control the hot gas flow from the ends of the distribution tube to provide uniform heating at the ends of the vessel. Finally, the hot gases escape

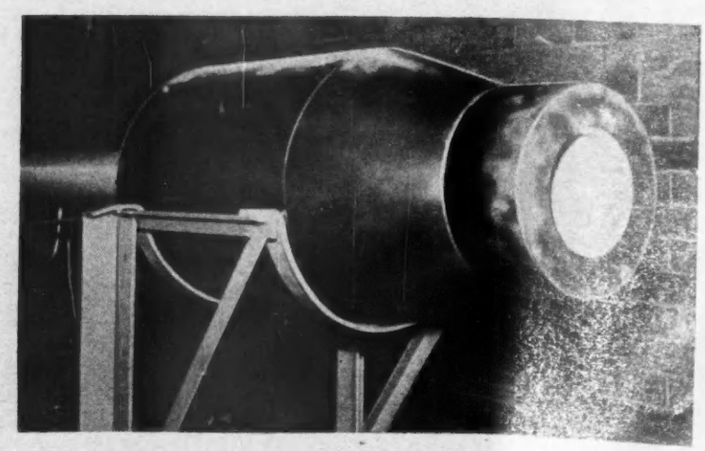

Fig. 2. High velocity jet type gas burner.

through the same vent through which the burner fires, as shown in Figure 4. Since it is necessary to record the temperature of the vessel at points not more than 15 feet centres, steel blocks were welded to the vessel and carried the thermocouple wires. A continuous record of the vessel temperature was maintained over the heating and cooling periods and experience seems to indicate that the temperature schedule can be maintained even more accurately than is at present required by the B.S. Actual records obtained are shown in Figure 5. The following data give some idea of the performance achieved in the stress relieving of the high pressure cylinder shown in Figure 1.

Dimensions of Vessel

Length.....Approximately 46 ft.
Diameter.....9 ft.
Plate thickness.....$\frac{7}{8}$" shell, 1" endplates
Access hole.....18" diameter, 6 ft. from end
Weight.....Approximately 21 tons

Burner Dimensions

Overall length.....28"
Exit port.....4½"
Air supply pressure.....40"
Air capacity available.....1000 c.f.m.
Gas maximum capacity....7000 cu. ft. per hr.
Jet speed (tunnel exit)....Approx. 400 m.p.h.
Recirculating tube.....15" diameter
Discharge holes..3"—3½" dia. holes along its length with 6"—9" end discharge.

Operational Details

Normal heating rate.....7 hrs. to reach 600°C
Approx. gas rate.....4200 cu. ft. per hour

The thermocouple readings over the period under investigation are given in Figure 5 and the inspecting authorities showed a great interest in the process, which they thought to be an improvement over prevailing methods. It is of interest to note that the Rocksil lagging cost about £280 with an additional £75 for its application and the installation of the centre tube. It is thus obvious that stress relieving of large vessels can now be carried out at minimum capital cost by fabricators without furnaces, eliminating transport to furnace plant with freight charges estimated at no less than £1 per ton per mile.

This is, of course, only one practical application of furnaceless heating. The North Eastern Gas Board and Messrs. Clayton Son & Co. Ltd. are experimenting with the erection of a temporary furnace which might be likened to a form of Nissen hut in sheet metal. This is lagged with Rocksil, and irregular shaped articles of large tonnage may be placed inside this canopy. Once again a central tube arrangement is used, the jet burner being so placed that the whole of the irregular shaped component may be uniformly heated. Such a furnace is to be built by Messrs. Claytons.

The North Eastern Gas Board is also using this for the drying out and heating up of large glass furnaces after they have been repaired or rebuilt. Here again is an instance where the time/temperature schedule must be rigorously controlled because of the various physical and chemical changes which occur in the furnace brick work during drying out and pre-heating periods. The summarised advantages of furnaceless heating include:

a Minimum capital cost.
b It is no longer necessary to occupy permanent factory space with a huge furnace.
c Reduced running costs.
d The advantages of stress relieving *in situ.*

The North Eastern Gas Board is convinced of the importance of the applications of the principle of high velocity jet type burners for many heat treatment processes without using a permanent furnace structure. Typical applications include pressure vessels for the chemical and oil refinery industries as well as those employed in nuclear energy projects. This is one example only of the manner in which the Industrial Development Centres of the Gas Boards undertake work on behalf of and in co-operation with manufacturers. Their experiences are interchanged so that any manufacturer approaching his Industrial Gas Engineer has the benefit of this co-ordinated knowledge of applied industrial gas techniques.

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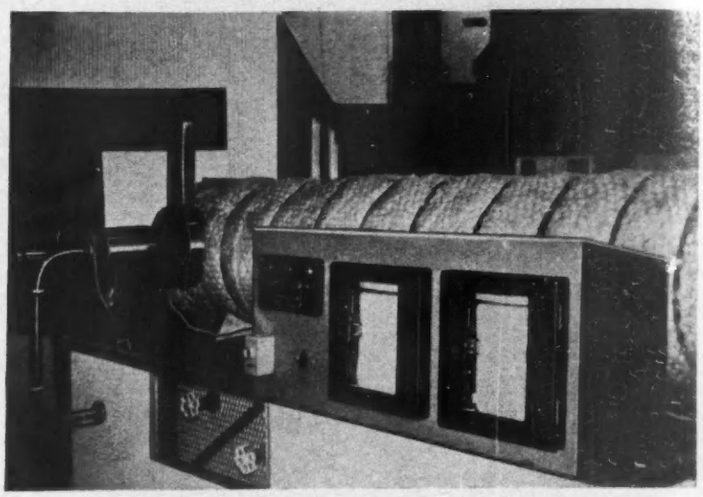


Fig. 3. Model of equipment used in furnaceless heating process.

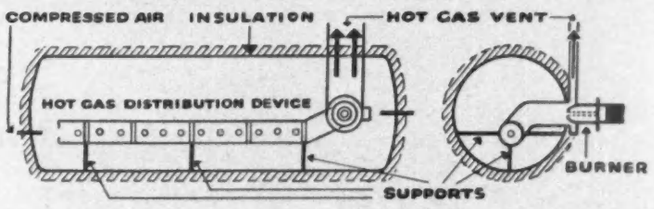


Fig. 4. Diagrammatic section through lagged cylinder showing burner jet and distribution tube.

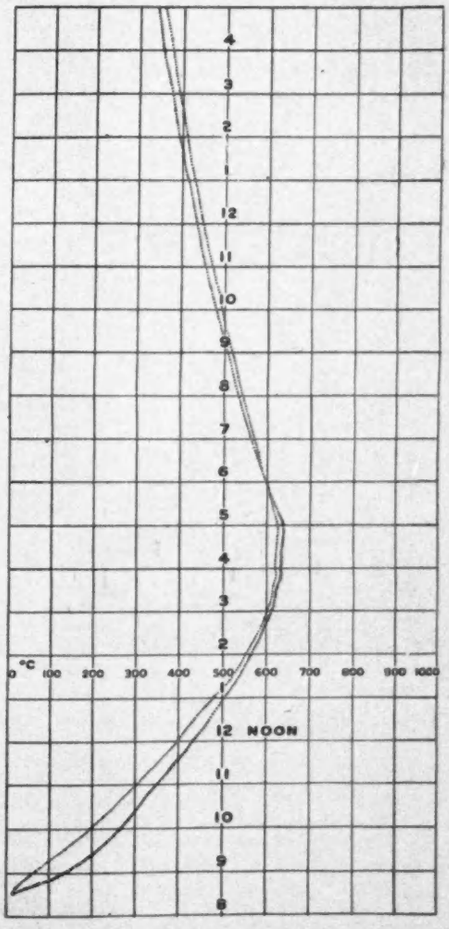
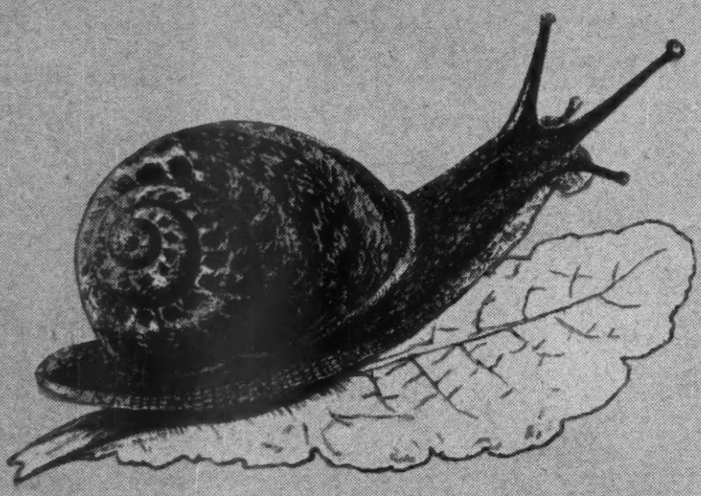


Fig. 5. Continuous temperature recording of heating and cooling process. (Maximum and minimum curves of the 12 points recorded).



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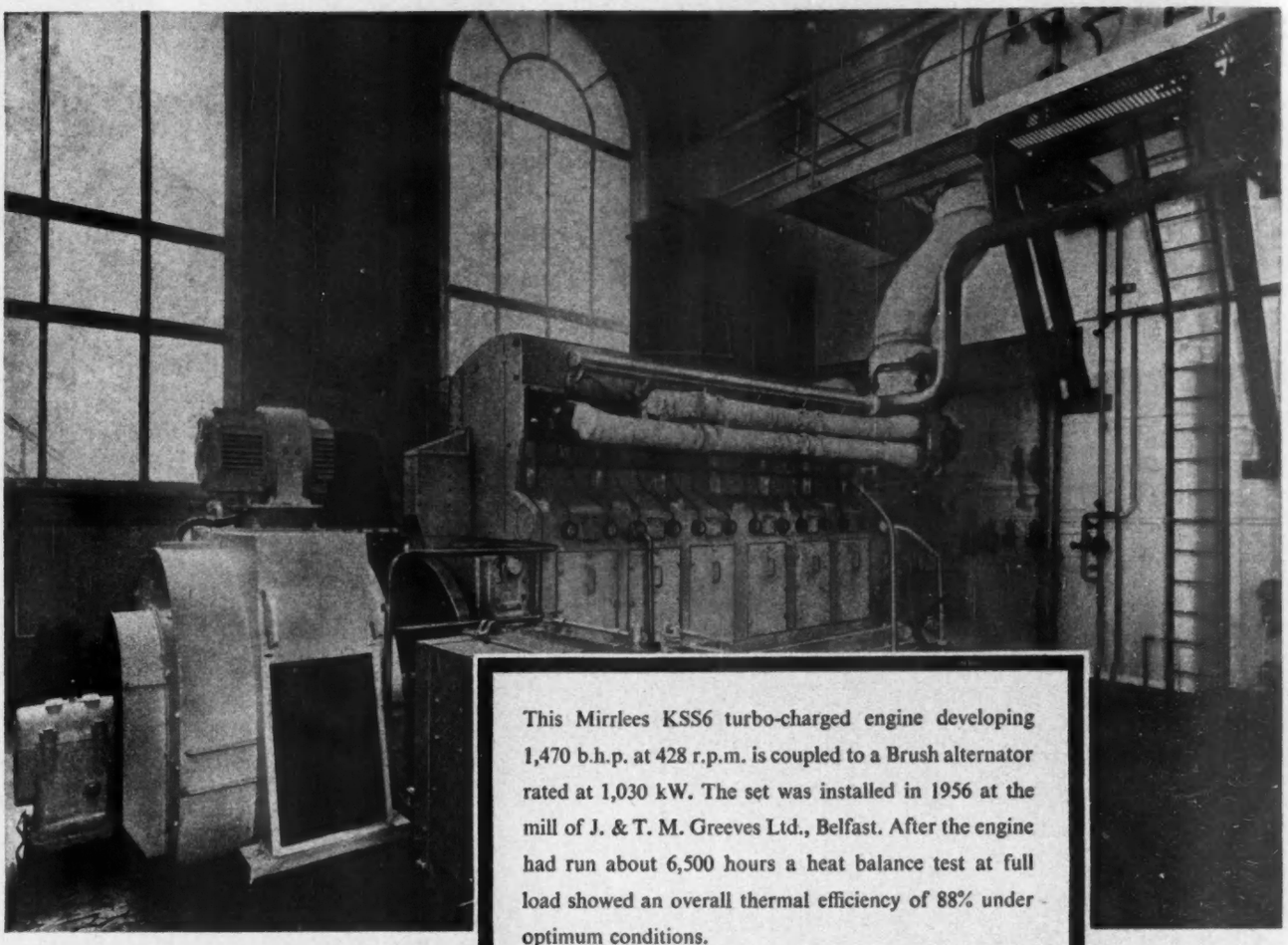

This Mirrlees KSS6 turbo-charged engine developing 1,470 b.h.p. at 428 r.p.m. is coupled to a Brush alternator rated at 1,030 kW. The set was installed in 1956 at the mill of J. & T. M. Greeves Ltd., Belfast. After the engine had run about 6,500 hours a heat balance test at full load showed an overall thermal efficiency of 88% under optimum conditions.

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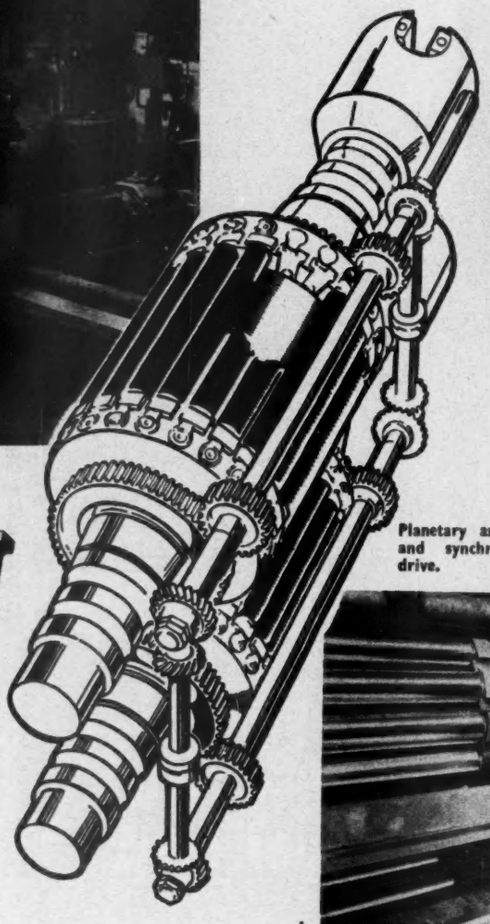
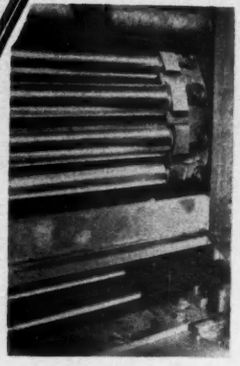


Planetary assembly and synchronizing drive.



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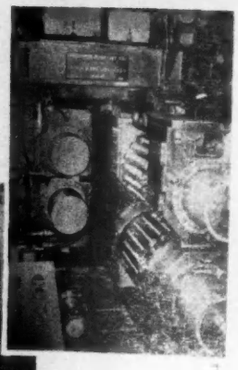
1. Planetary rolls seen from exit side.
2. Planetary assemblies withdrawn from housings.
3. Grooved feedrolls and water-cooled central slab guide.



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3

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This mill is designed to produce hot rolled strip up to 15in. wide and as thin as 0·048in. from slabs 1¾in. thick in mild, high carbon and stainless steels.

The mill consists essentially of feed rolls, planetary roll assembly and a final two-high planishing mill followed by coiling equipment. Nominal output is 10 tons per hour which has already been considerably exceeded.

Surface finish is fully up to the standard required for subsequent cold rolling.

This is the second Planetary Mill in Great Britain, both of which have been

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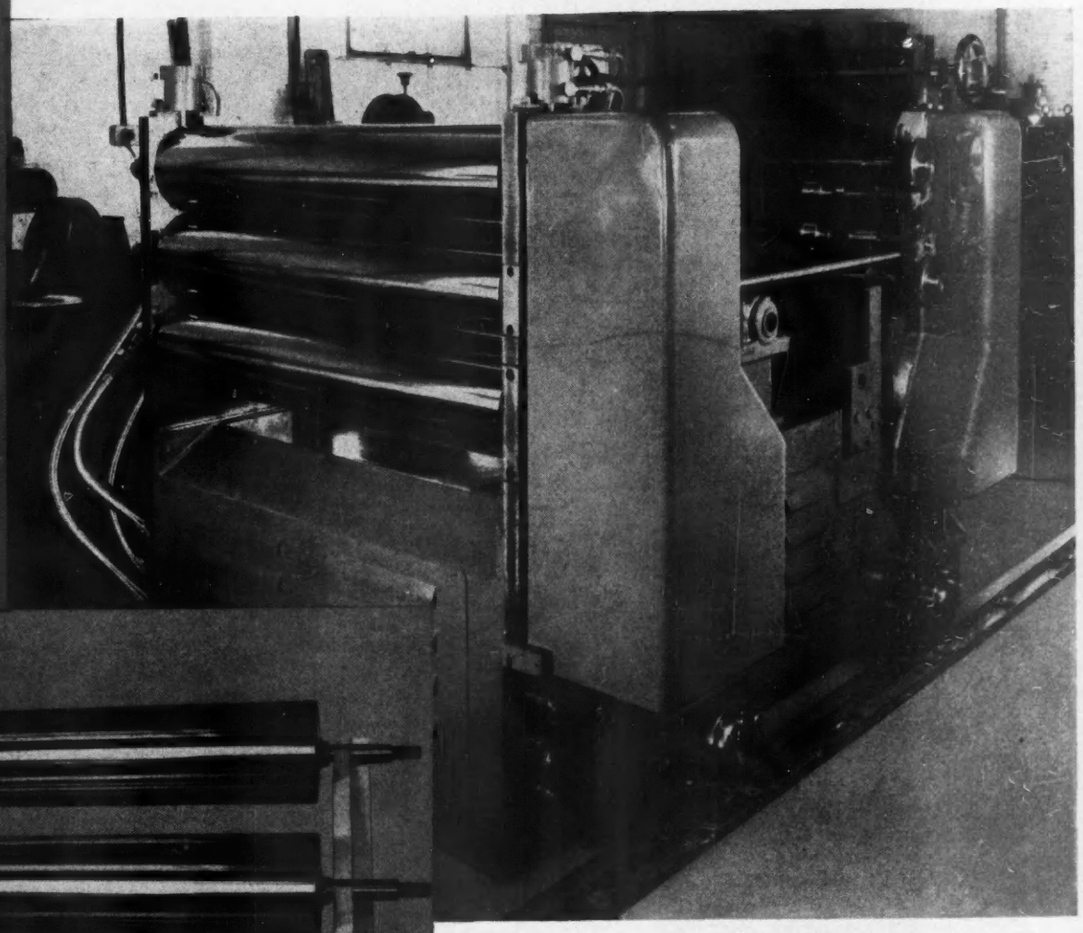

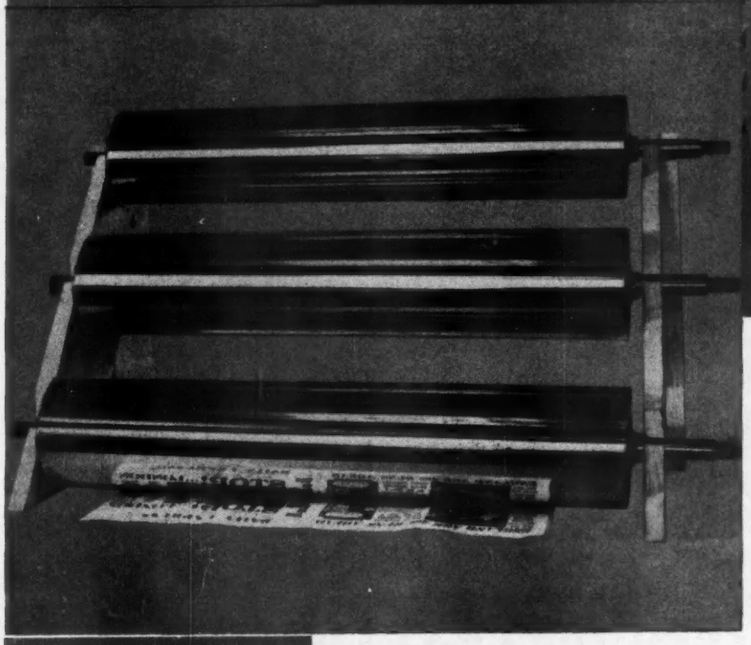

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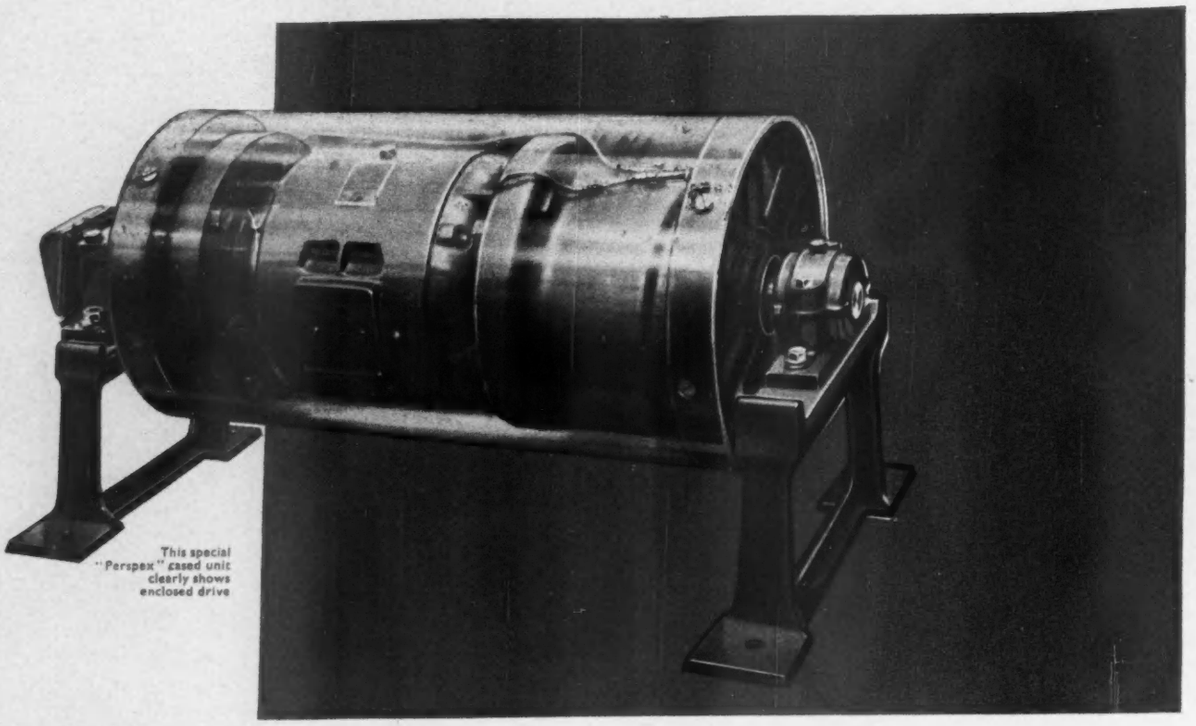

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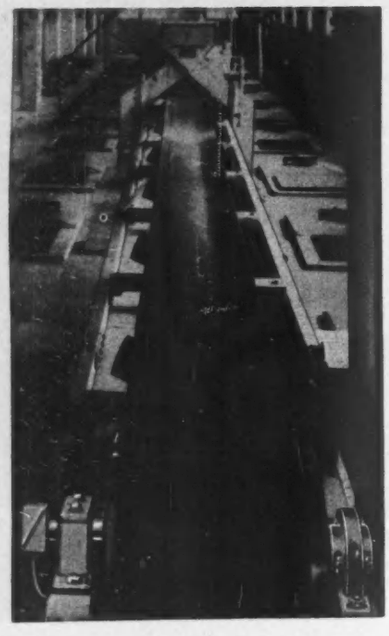

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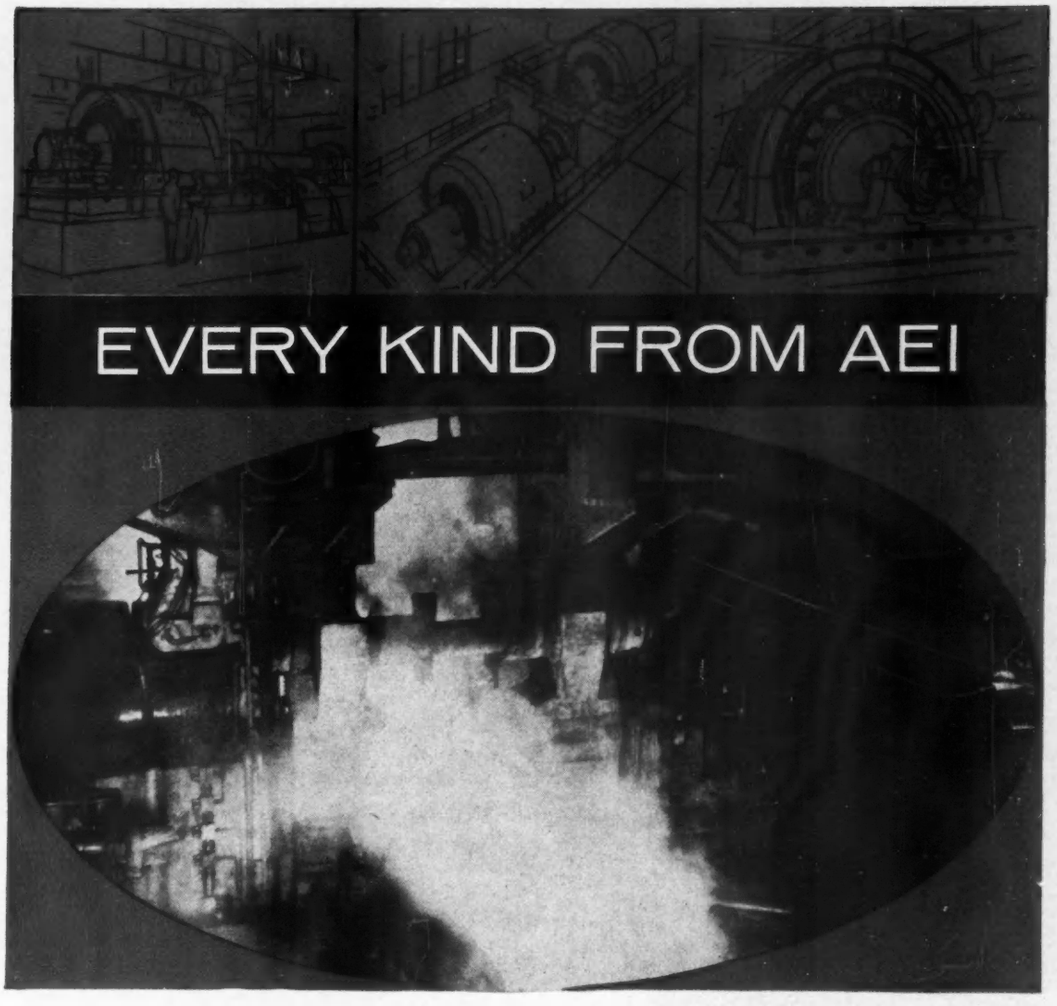

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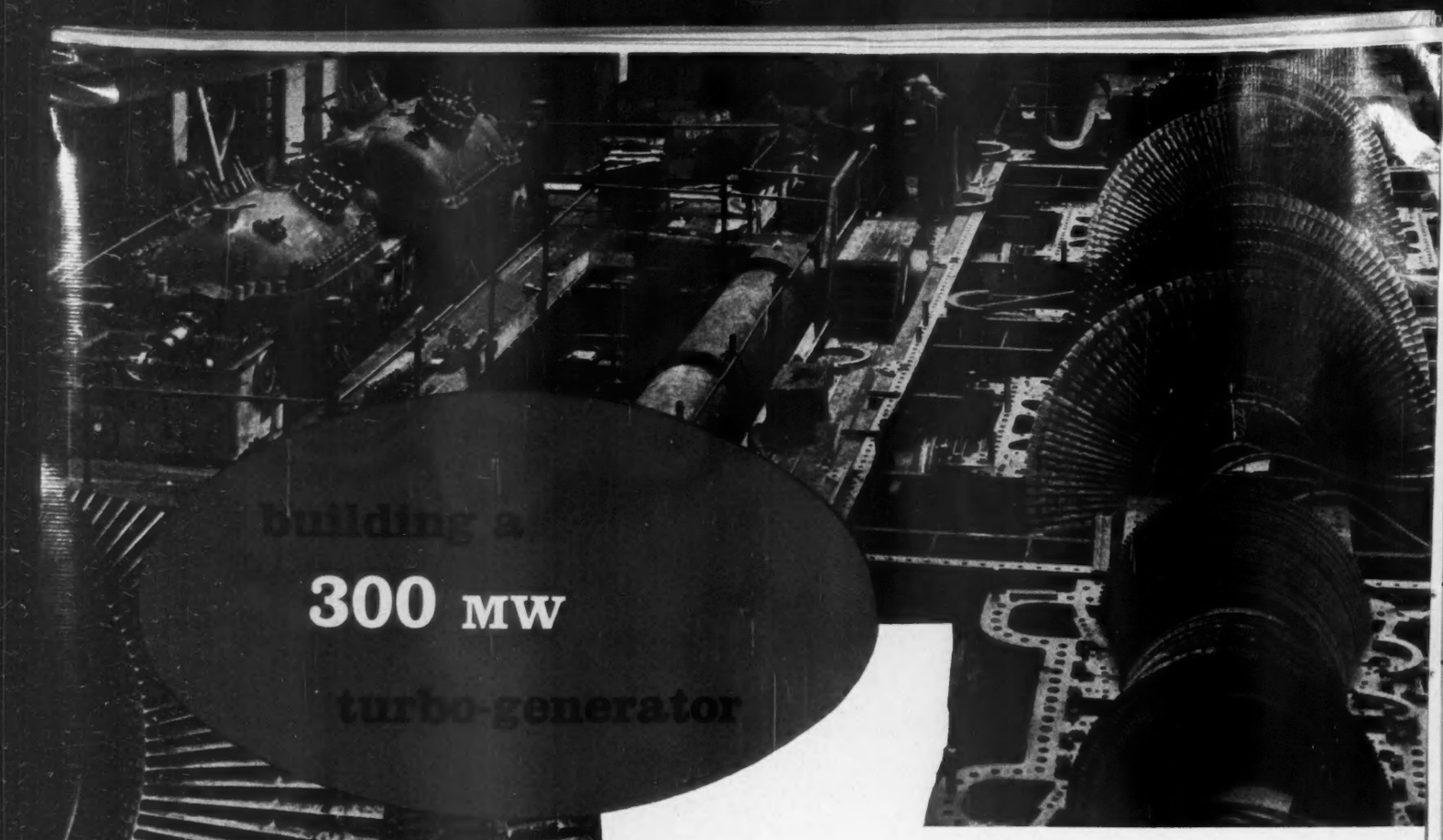

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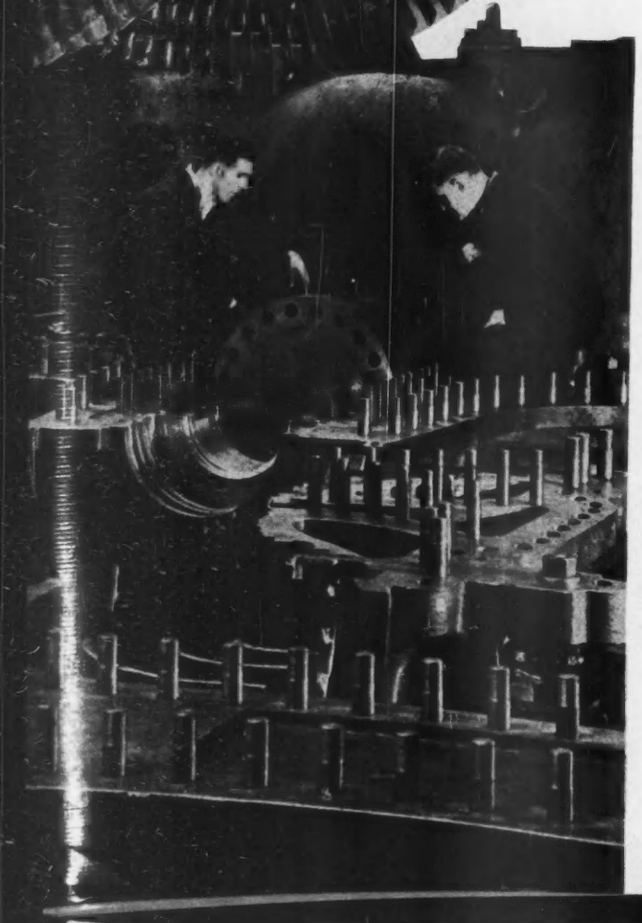

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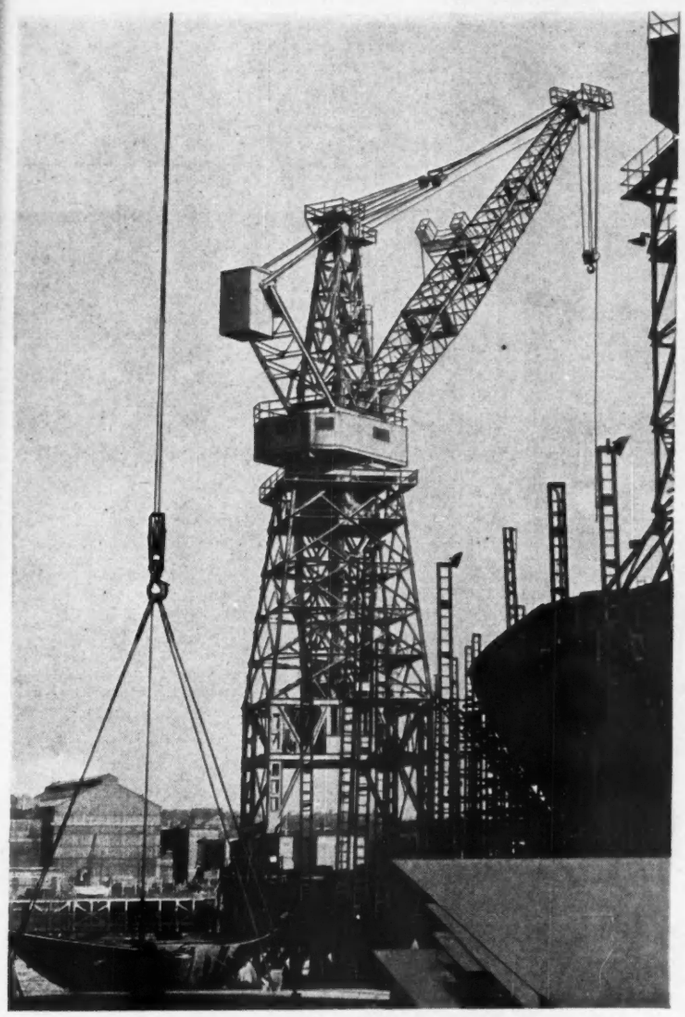

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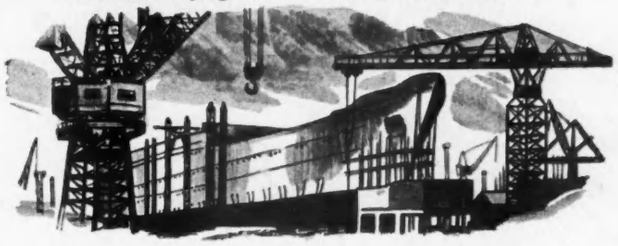

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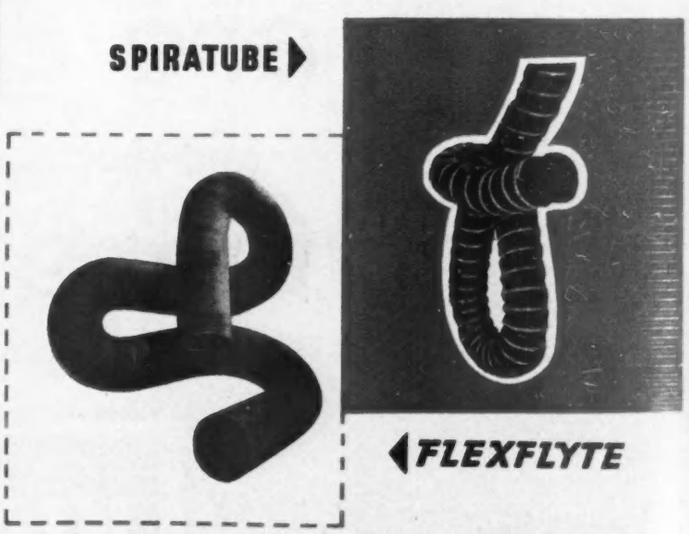

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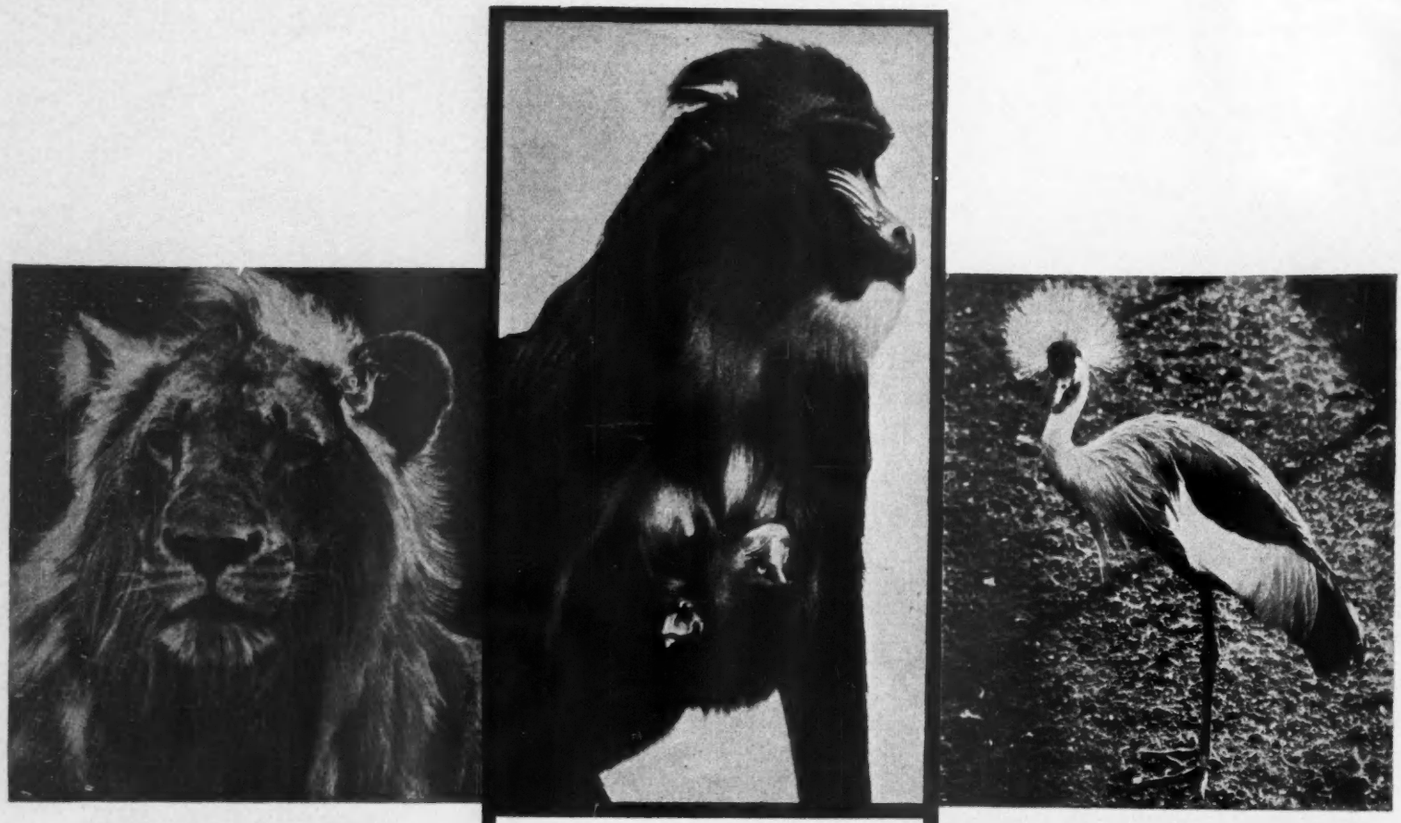

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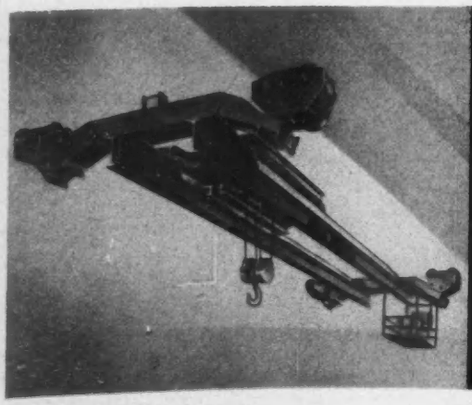

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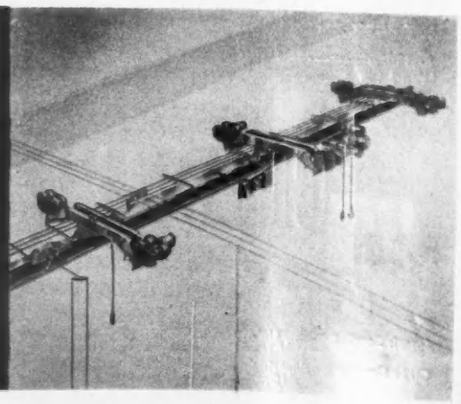
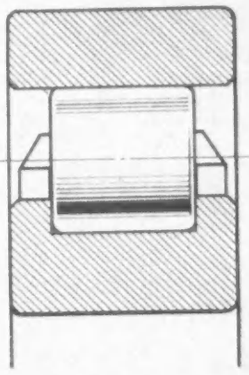


R&M parallel roller bearings

meet the case, when shock loads occur, and shafts expand or contract



These bearings are in earthworking and bulk handling equipment, in vibrating screens, electric motors and other machines of all shapes and purposes.

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Publication 37 is a comprehensive guide. Consult the R&M Technical Department for advice or assistance of any kind to do with bearings. Ransome & Marles knowledge is at your disposal without charge or obligation, and your enquiry will, of course, be treated as confidential.

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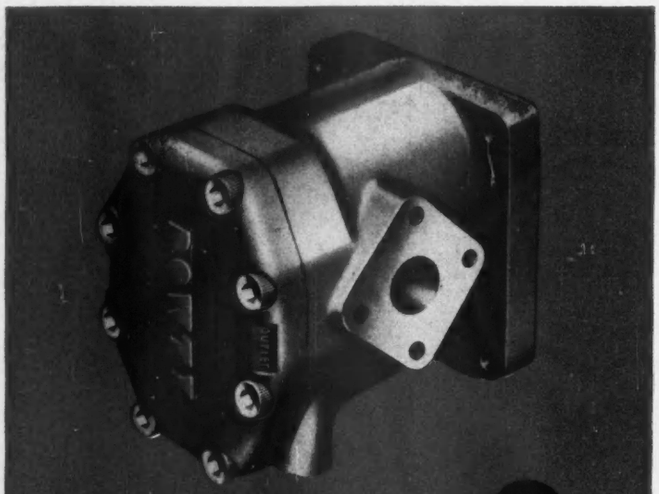

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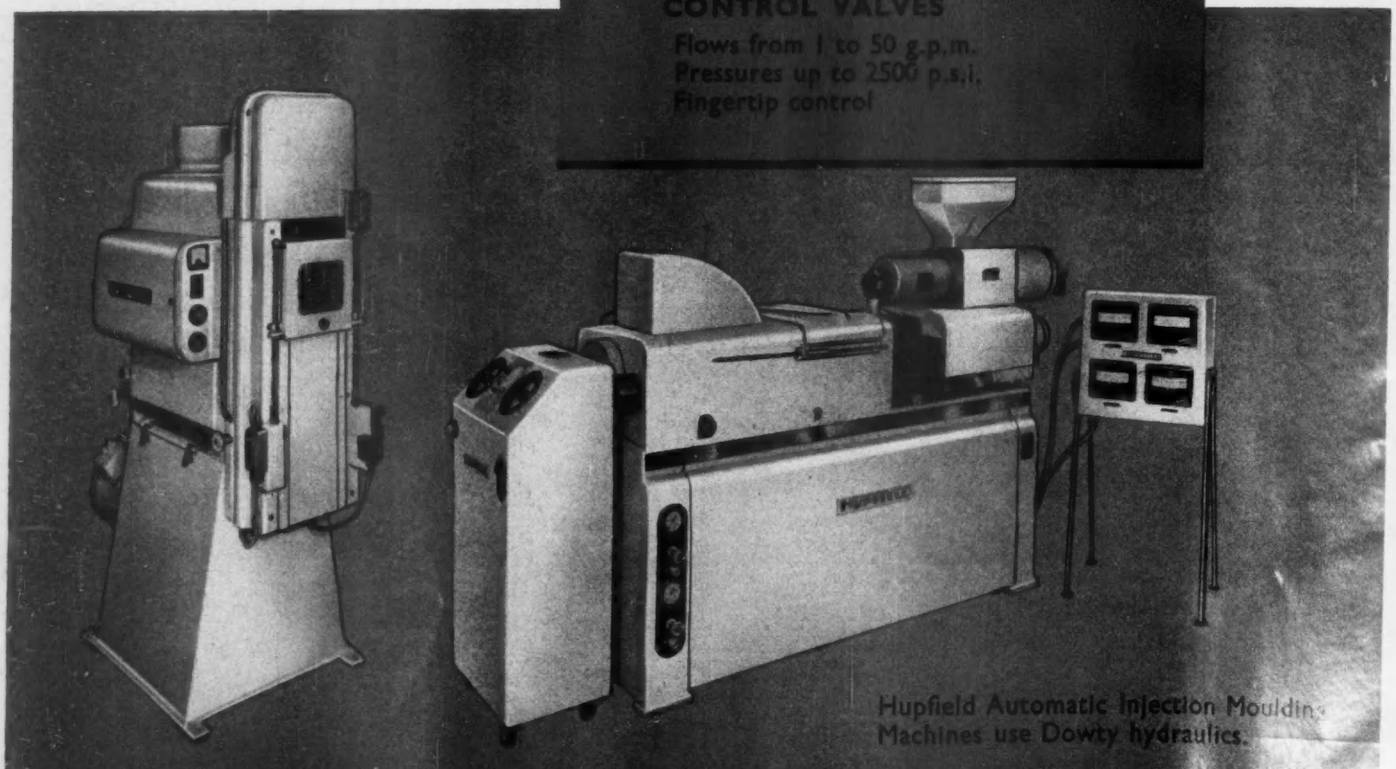

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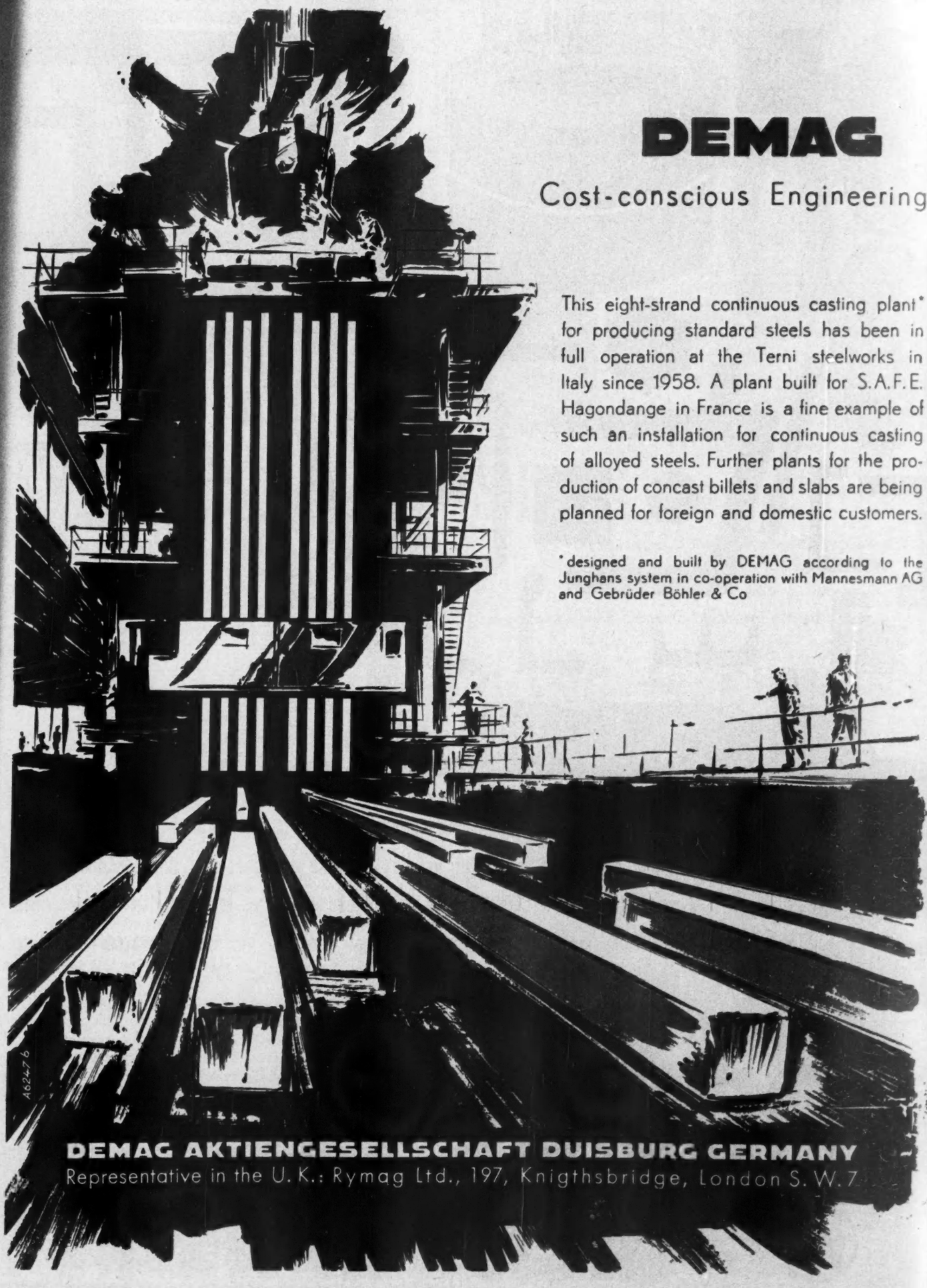

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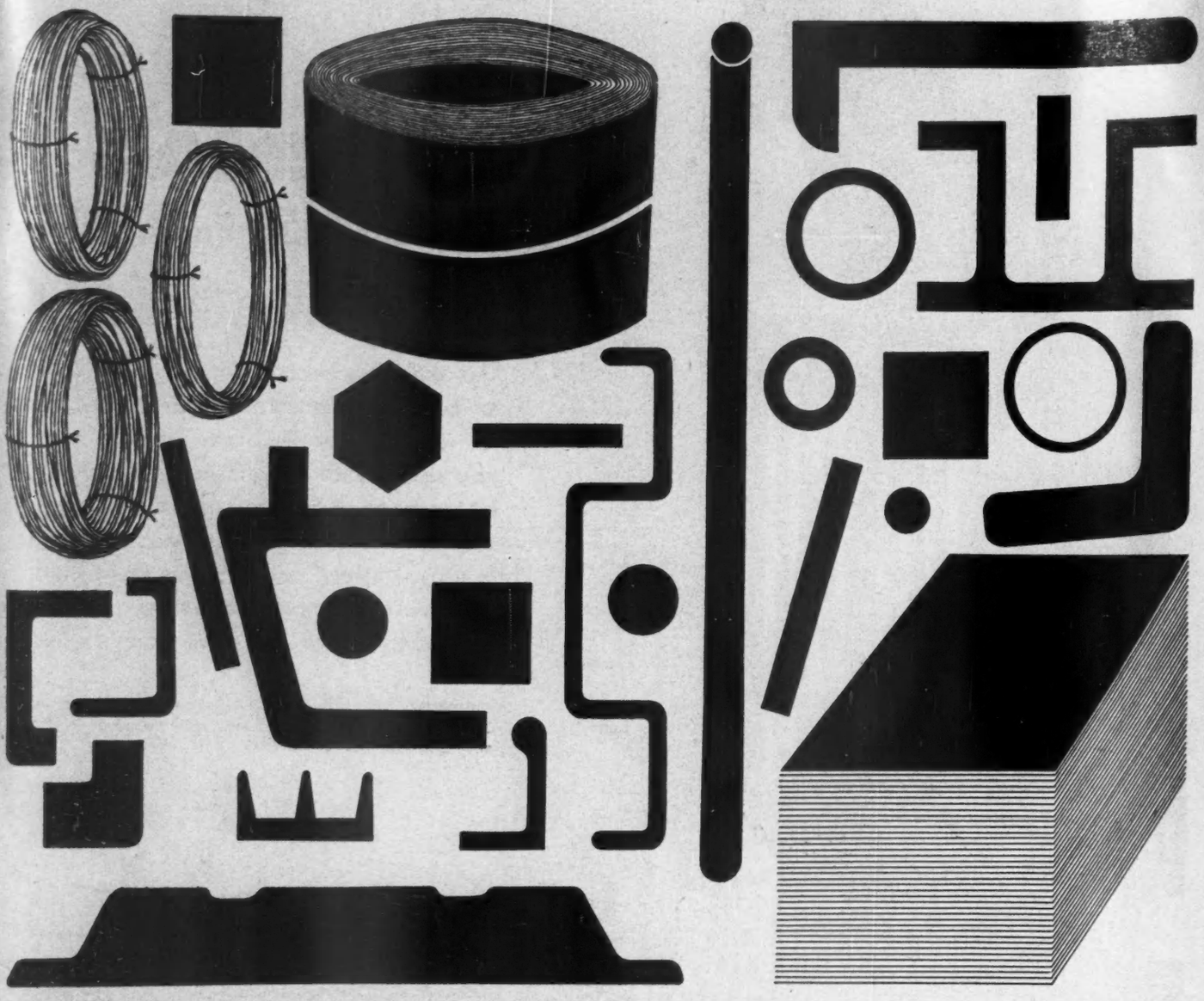

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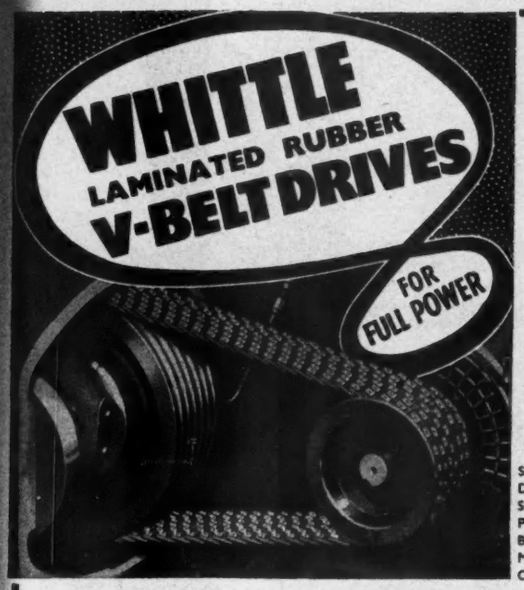

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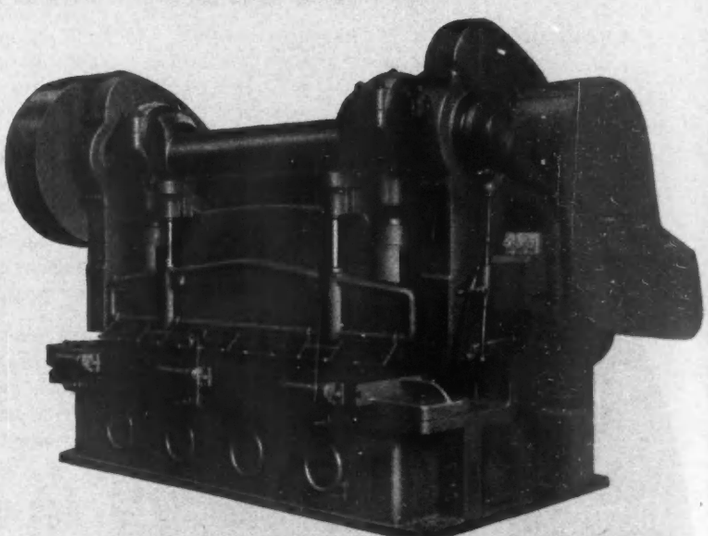

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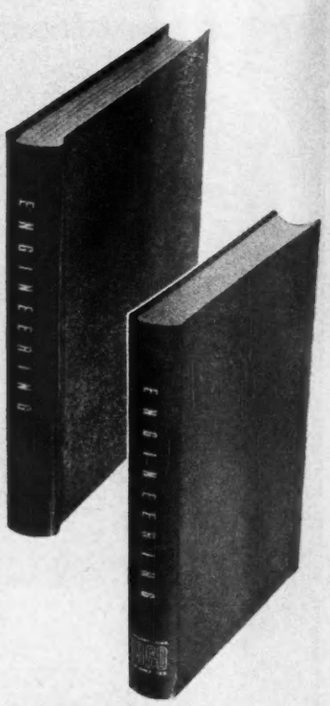

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Electrical Aids in Industry

Data Sheet **No. 12**

Dielectric Heating - 3

Some further details of the uses to which dielectric heating can be put are given in this data sheet, being continued from data sheet No. 11.

The Woodworking Industry

A most important development in recent years in the woodworking industry has been the introduction of synthetic resin adhesives of the thermosetting type for the bonding and adhesion of wooden components.

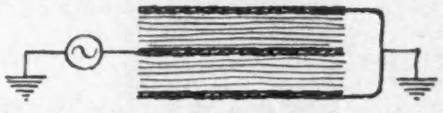
Setting of these resin adhesives proceeds at a rate largely determined by temperature. For instance, urea formaldehyde, one of the resins in common use, sets as follows :

TEMPERATURE	SETTING TIME
65°F	3 hours
80°F	1 hour
150°F	3 minutes
190°F	1 minute

The resultant bonded joint is equally satisfactory in each case. Most of the power supplied when dielectric heating is used is absorbed by the resin, the heat thus being concentrated where required and power consumption reduced to a minimum.

Plywood

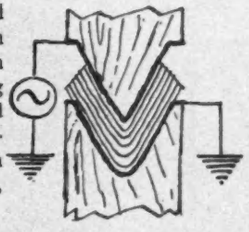
With dielectric heating consuming power only during the heating cycle, plywood can be produced with considerable savings in heating times and costs.



For example, in a press holding 100 3-ply ¼" thick assemblies, the resin glue is set in 20 to 30 minutes, depending upon the dryness of the wood. An output of up to 60 cu. ft. of plywood is obtained per hour using a 25 kW H.F. generator.

Curved Laminated Sections

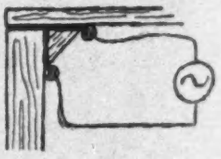
Curved laminated sections are being increasingly used in contemporary furniture, and with dielectric heating rapid production can be achieved using wooden shaping blocks in single daylight presses. An alternative method of providing heat by conduction from heated metal strips becomes increasingly slower as the total section thickness rises above 0.05 inch, as shown below:



TOTAL THICKNESS OF LAMINATIONS	*Comparative heating times in minutes*	
	CONDUCTION	DIELECTRIC
1 inch	20	4
⅜ inch	5½	2½
0.6 mm veneer	1	1½

Furniture Assembly

Because of the savings in glueing processes already instanced, dielectric heating is being extensively used in the furniture trade. It leads also to reductions in labour and floor space, with the elimination of assembly jigs. The heating equipment can be placed directly in the production line, cutting handling to a minimum.



Resin-bonded Wood Chipboard

A substitute for natural timber is made from wood waste and chippings, broken down to a coarse size, mixed with synthetic resin and heated under pressure. Dielectric heating gives quick and uniform heating, and increased fluidity reduces the power required for the final pressing and curing operation. In a continuous process, the length of the press required is also reduced.

Blockboard

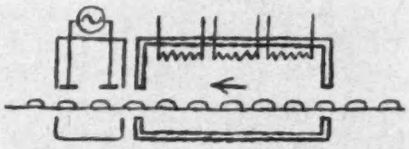
Production of blockboard by edge glueing strips of wood also provides an excellent use for dielectric heating, since considerable savings in time and labour can be effected owing to the large areas of glue line involved.

Other Resin-bonded Products

Dielectric heating is also used in the manufacture of other resin-bonded or impregnated products such as grinding wheels, impregnated woods, fabrics, felts, glass-fibre and similar products.

Foodstuffs

Increased use is being made of dielectric heating in many processes connected with foods; these include de-freezing and melting, sterilisation and disinfestation, drying of breakfast cereals, dog biscuits, rusks, etc., heating of nuts to facilitate shelling and other similar types of application. Although some cooking processes are technically possible, as for example bread baking, the 'unbrowned' product has so far proved unacceptable to the public and a completely dielectric process uneconomical. When combined with conventional baking, however, as now in the biscuit trade,



where dielectric heating is being used to complete the baking of biscuits, it can produce normal biscuits in ¼ to ½ the usual baking time.

There are in fact so many potential applications of dielectric heating (and these applications are increasing daily as the chemical industry develops new products, as for example synthetic fibres) that the selection given in the present series of data sheets covers only a part of the whole field.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available — "Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

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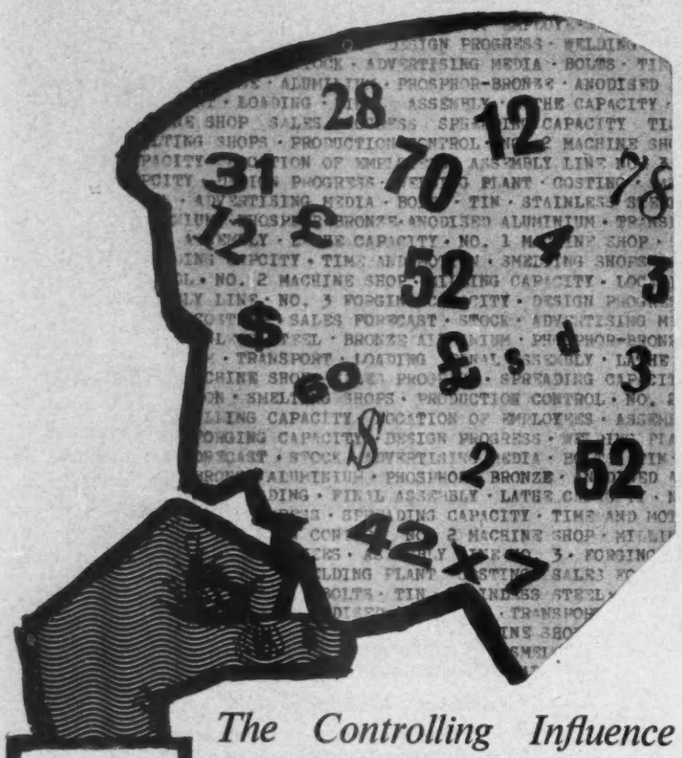

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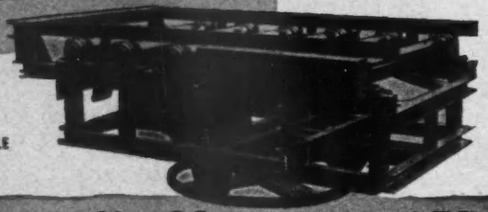

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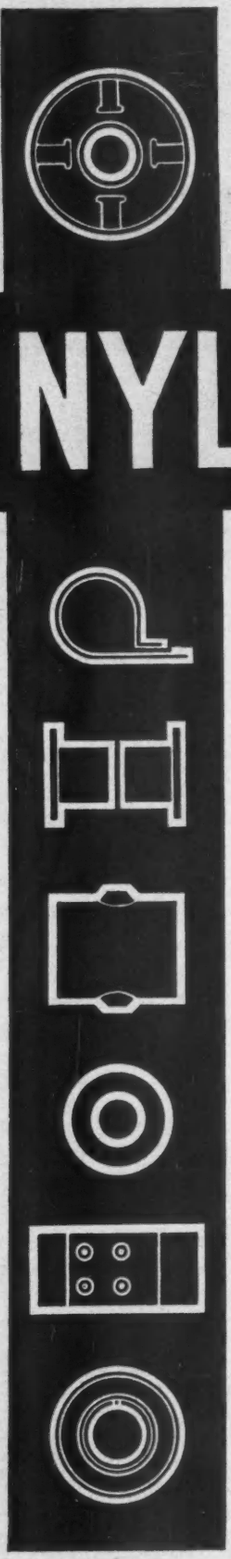

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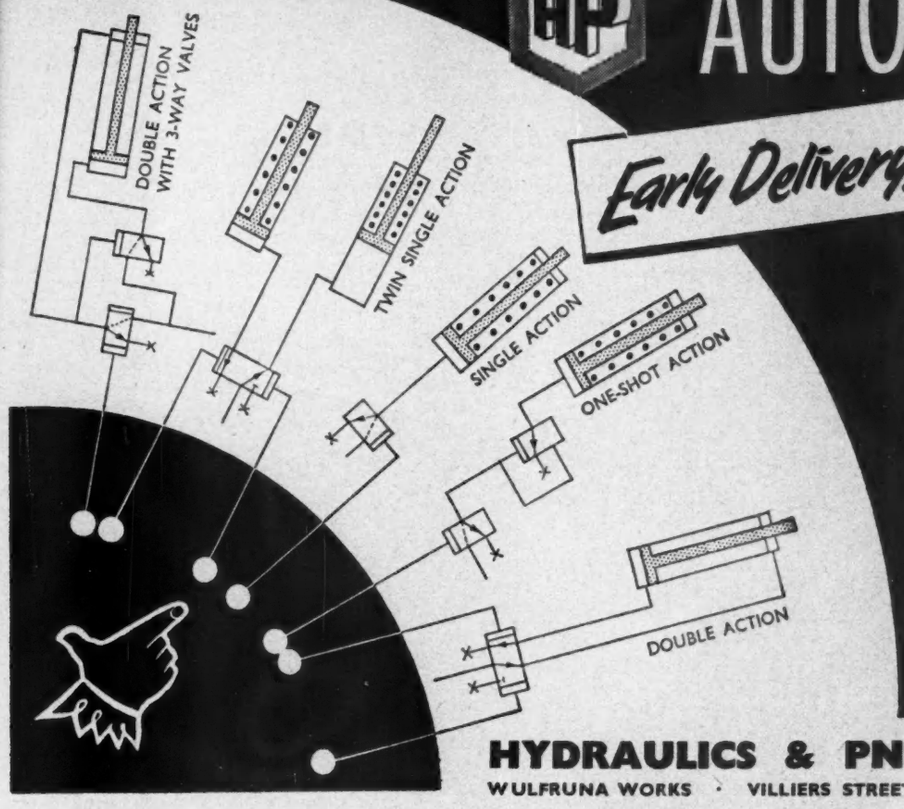

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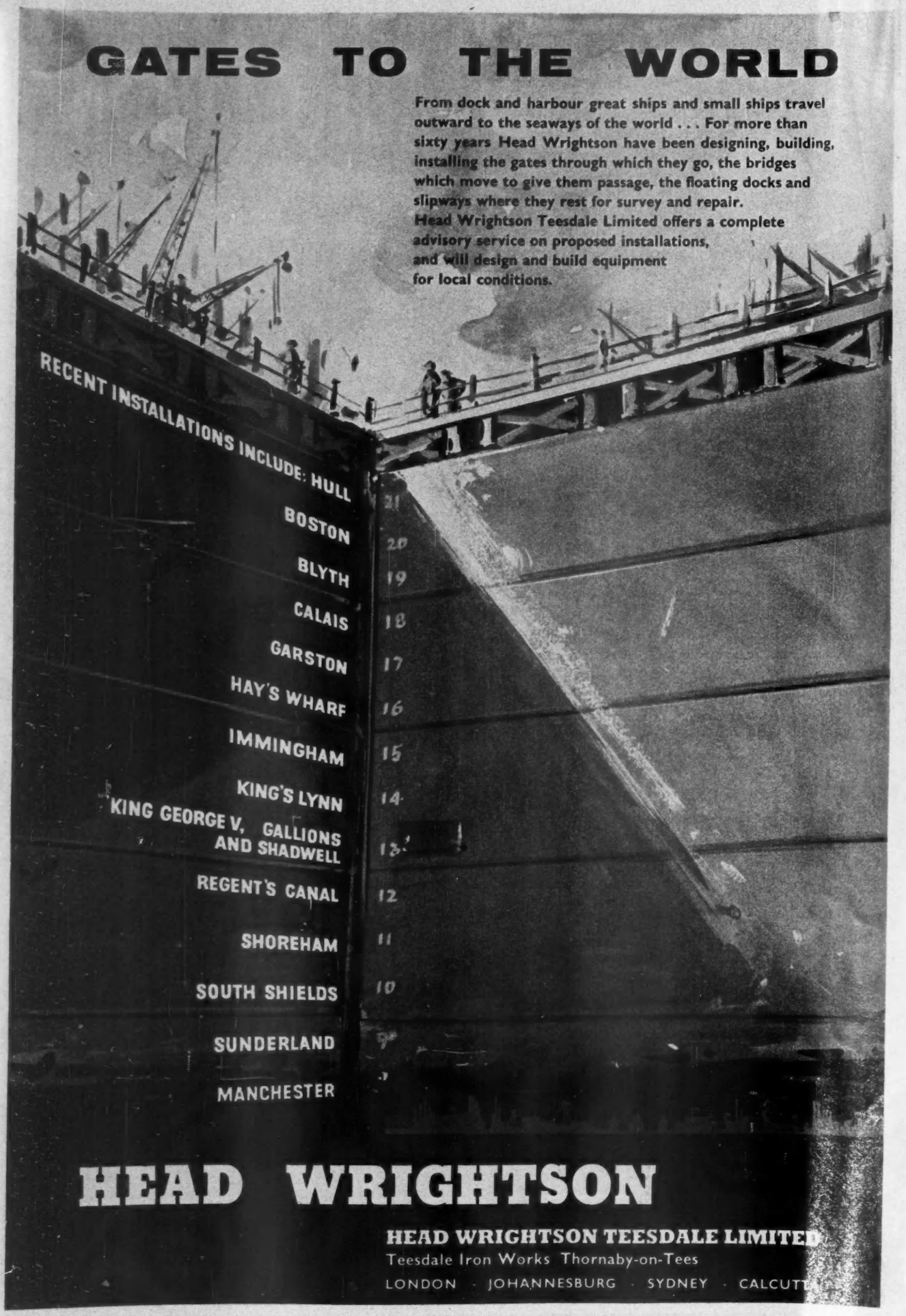

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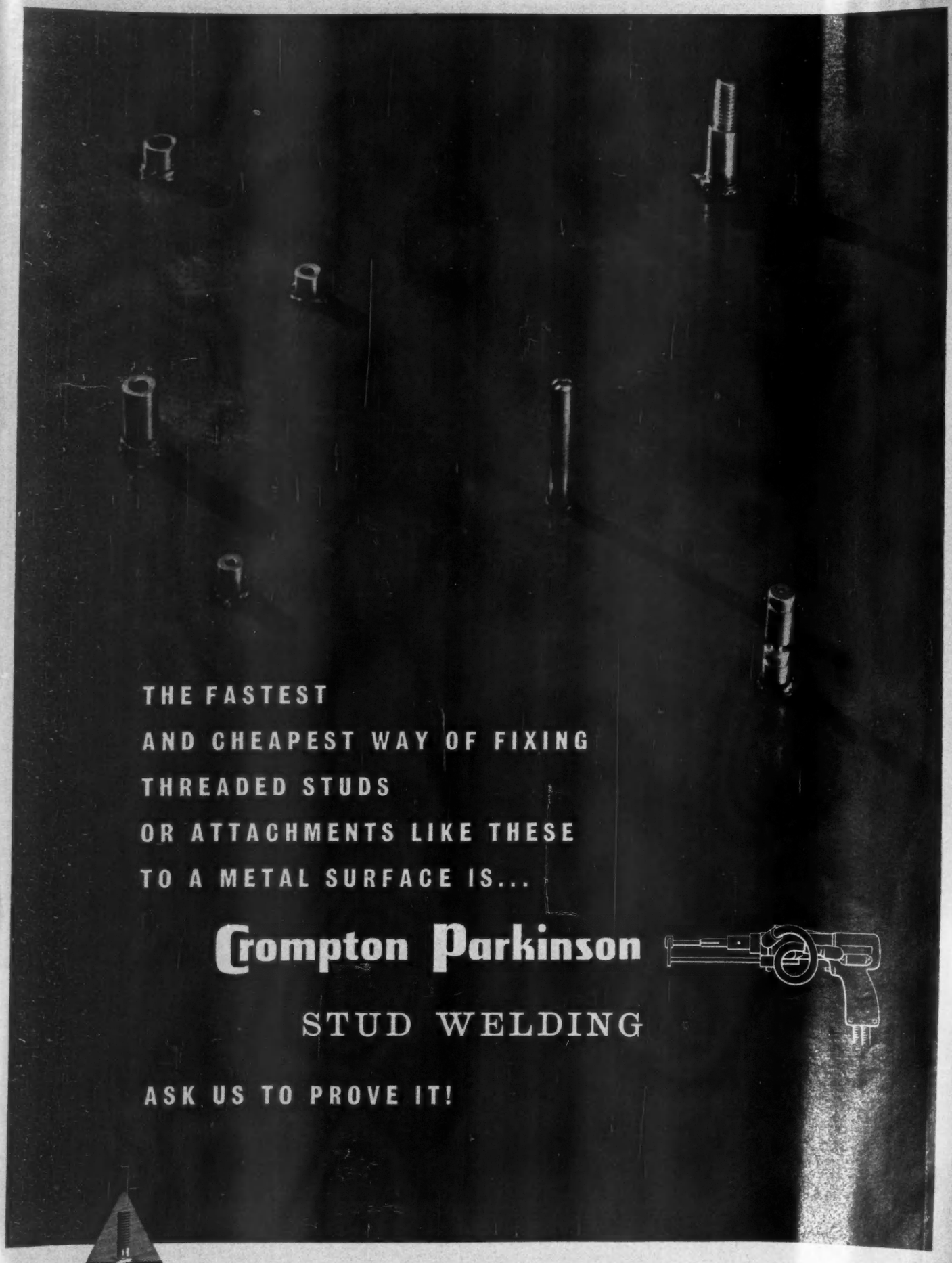
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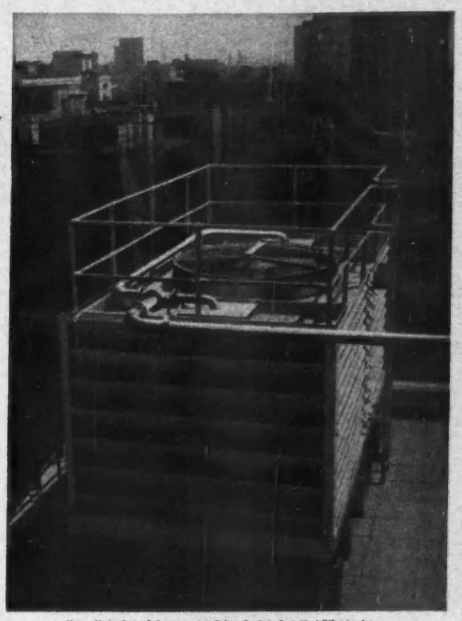

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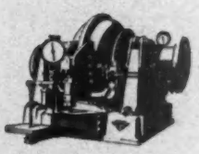

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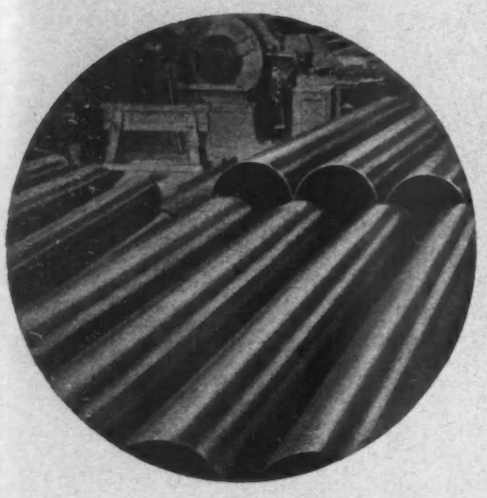

First the tube...

Hundreds of industrial products include a Chesterfield tube in one form or another: products involving seamless steel tubes up to 39" internal diameter, in Carbon, alloy and stainless steels, in quantity production and one-off designs. If you manufacture anything from, with, or in tubes, we'd like to hear from you.

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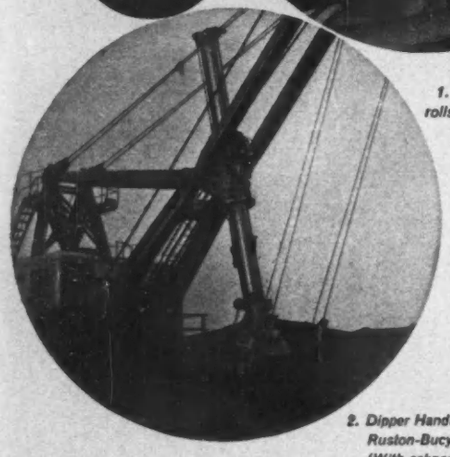
1. Hard rubber covered dry felt rolls on paper making machines. (With acknowledgements to Millspaugh Ltd)



2. Dipper Handles for 200-ton Ruston-Bucyrus Excavators. (With acknowledgements to Ruston-Bucyrus Ltd)

chesterfield tubes

THE CHESTERFIELD TUBE COMPANY LIMITED,
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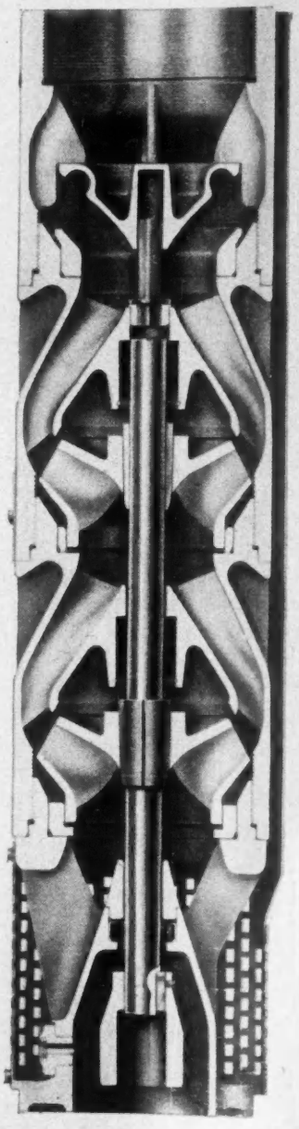
CRC66

Submersible Breakthrough



Sumo designers have effected a remarkable increase in the efficiency of standard production submersible pumps compared with anything attainable hitherto. *Pumping losses have been reduced by as much as 20%.*

Here are some of the results that follow from this breakthrough.

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These new *mixed flow pumps* are being made for 6", 8" and 10" diameter boreholes.

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Sumo

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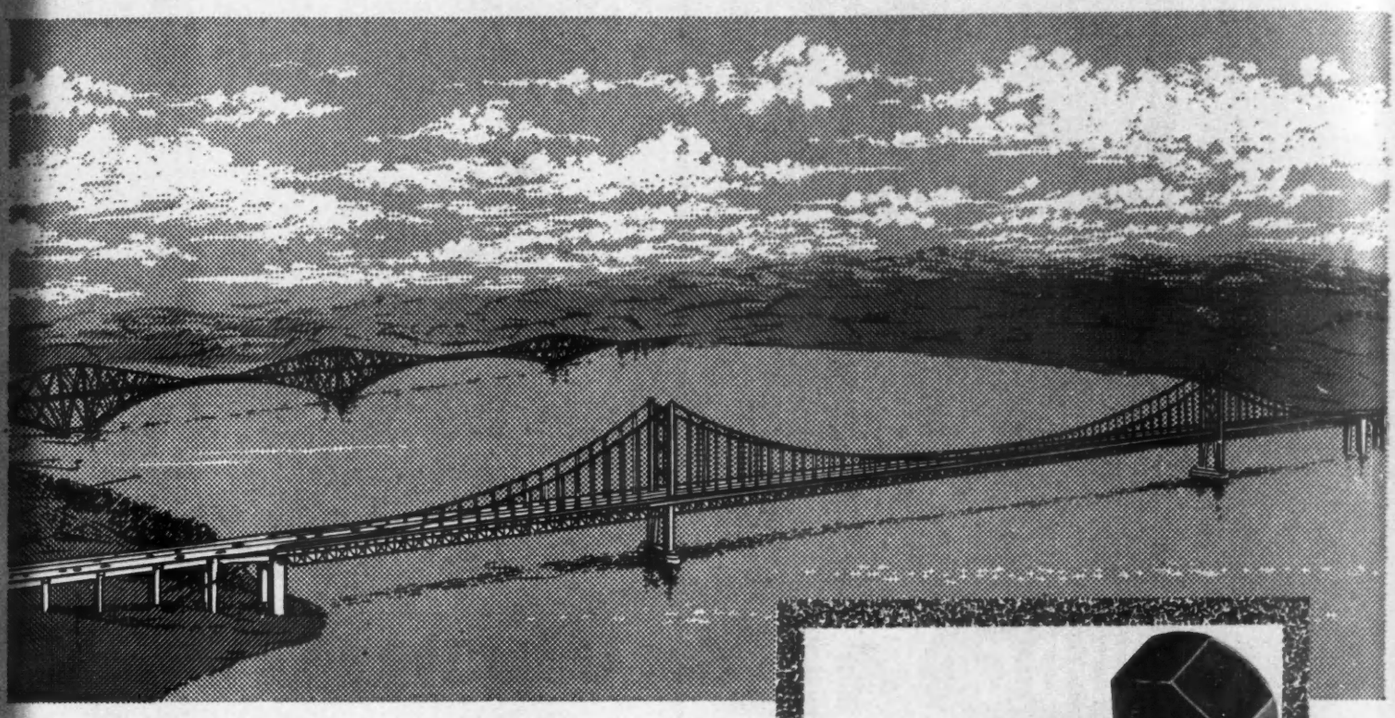

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The 'Newallastic Structural' Bolt

Patent applied for

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A. P. Newall & Company Limited are happy to be associated thus with the contractors (Contract No. 2)—the A.C.D. Bridge Company—a partnership comprising :—Sir William Arrol & Company Limited, The Cleveland Bridge & Engineering Company Limited, Dorman Long (Bridge & Engineering) Limited; — and with the Consulting Engineers; Messrs. Mott, Hay & Anderson and Messrs. Freeman, Fox & Partners.

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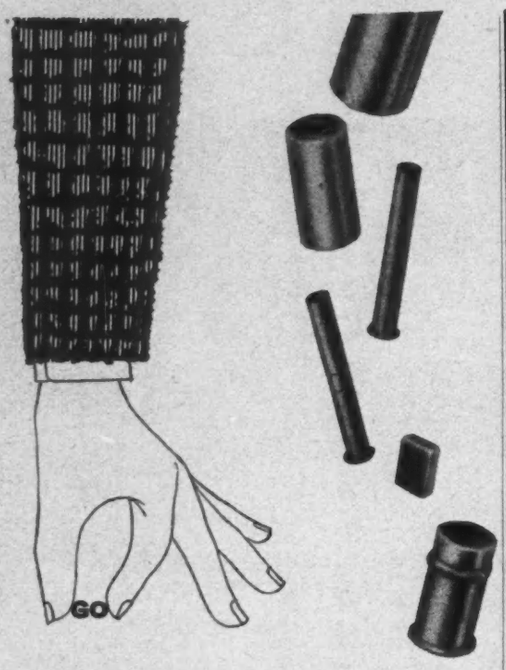

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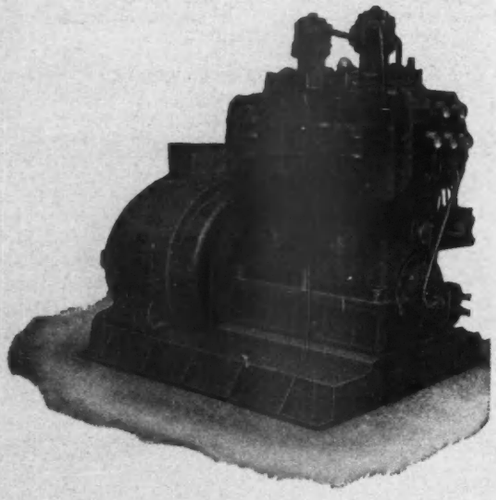

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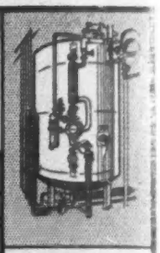

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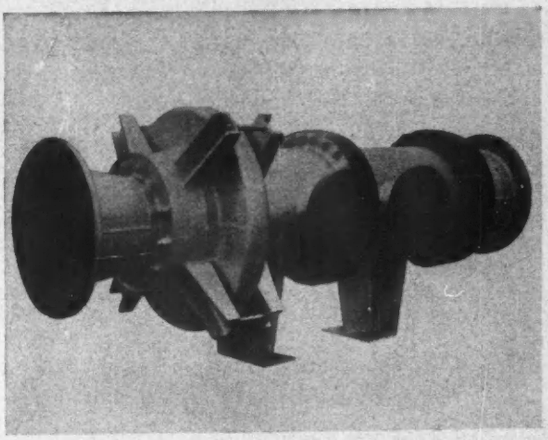

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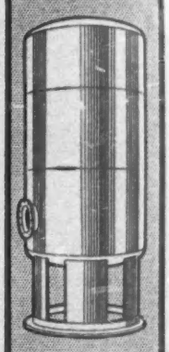
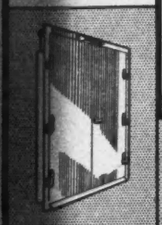


STORAGE TANKS



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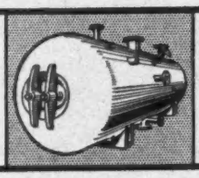

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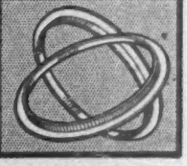

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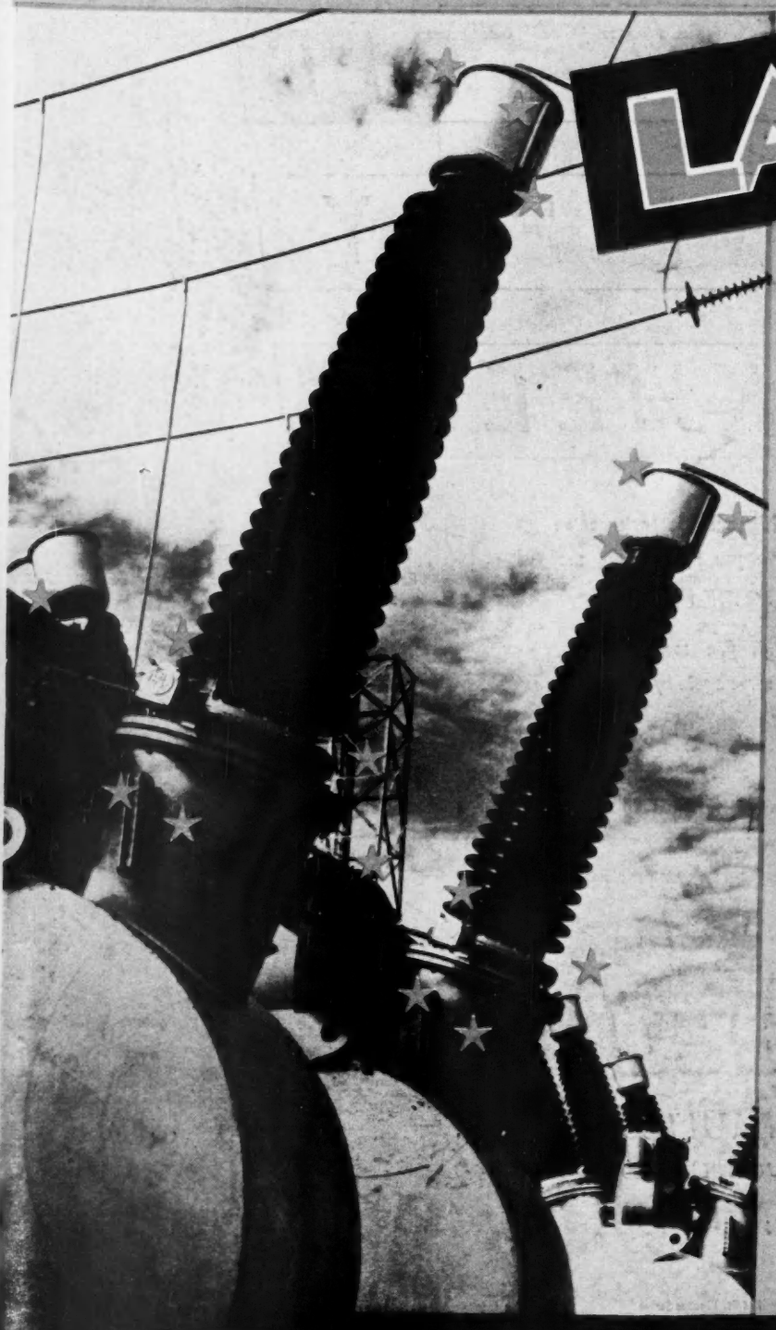

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